THE

ELECTRICAL REVIEW.

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ELECTRIC FEEDER LINES TO RAILWAYS.

IN our article of July 19th on "Electrical Feeders for Main Lines of Railways," we had before us the idea of utilising feeder lines, which now exist as branch lines all over the country, and are not used to an extent at all commensurate with their cost, and we endeavoured to show that the working of such lines, as steam lines, was a mistake, because it involved the running of a locomotive backwards and forwards many times a day if the public convenience was to be considered, but, in practice, had resolved itself into the running of two to five trains daily, which were not of much convenience to the public, nor were they an inducement to travel but simply left a very large section of the public to cater for themselves by private vehicles on the common road; that, in fact, the railways never seemed to have ever put forth serious efforts to secure business, but appear to have allowed themselves to be beaten by the difficulty and expense of steam traction, which will, in our opinion, always be so difficult to oust from the main line, where it finds its best field of effort. The recently opened Nantasket Beach branch of the New York, New Haven and Hartford Railway, as an electrically operated line, comes very close to the idea of the electrically operated English branch line, being about seven miles long, and laid with 70 lbs. rails, and double tracked. But we do not think that the electrical operation of our own branch lines by any means exhausts the possibilities of the electrical railway in this country as a main line feeder. We may take it that the existing branch lines have been built either because there appeared in prospect more business than the lines were able to get hold of when built, by reason of the very poor and infrequent accommodation provided, or that they were built as sops to conciliate some local influence or some local man who could influence business on another part of the system, but we may also take it as fairly correct to suppose that many more branch lines would have been laid if those which were constructed had shown a better return, for there are numerous places entirely without railway facilities that must have seemed, in railway building days, but little inferior in importance to others which were provided with such advantages.

The mistake made in the estimate of future probable traffic was not altogether a mistake so much as an error in judgment, the number of people leaving a certain town for another, during the day, being a fair basis on which to build an estimate for a tramway, but absolutely untrustworthy as a guide to the number who would pack themselves into one train at a given hour on a railroad. The general public is unpunctual, a fault the railways might have improved if they had not themselves become a by-word of unpunctuality. But no one ever complains of the unpunctuality of the 'bus

service between the Bank and Charing Cross, and why? Simply because, if there be any schedule of time, and we are absolutely in the dark as to this, the vehicles run so quickly one after another, like the cars on Broadway, New York, that it matters nothing to a passenger if the particular portion of the procession which he joins is five minutes or five hours behind time. He joins the procession and there he is, but when he goes to meet a train where is he? This is a simple matter, but it underlies the whole question of securing traffic, and, as we pointed out, would make a success of the branch railways, if it could be lived up to. Equally, then, with our experience of the mistake made in the past, of building branch lines to the scale of main line traffic, and our conviction that facilities for travelling afforded at frequent intervals the day through, both for going and coming, will ensure traffic, we would like to urge upon the railway companies the importance of not only remodelling their existing branches on electrical lines, but of following the lead of the Americans in building new feeder lines to be worked electrically, lines to be laid, as many thousands of miles have now been laid in America, along the highways, with perhaps an occasional excursion through the fields to shorten an inopportune corner, but mainly along the roads. It is not necessary to occupy even the roadway itself over the greater part of the distance, for the roads are rarely so stinted in width that there is not an ample "cess" on one or both sides that could be utilised for the purposes of a light railway. Rails proportioned to the traffic, not indeed too light, which is false economy, but wanting that excessive section necessary to carry the load of a steam locomotive, with sleepers on a fair bed of ballast, so easily drained to the existing side ditches, are all that is wanted to run a line to many an outlying town and village, which can be operated with perfect safety at the moderate speeds that are needed to satisfy the traffic. Frequency, not speed, should be the motto of the new lines. As regards the general construction, either steel sleepers, which would give a welcome fillip to the iron trade, or Australian hardwood sleepers would be sufficient without separate chairs; the durability of the latter sleepers is not to be spoken of in the same day as that of the inferior soft timbers now used by the railways. Signals are no more needed than on tram lines. This point is perhaps vital. Where speeds are high there must be signals, and at once is introduced expense. The only signal necessary might be one at times in the arrival yard and at the junction to the main line, but feeder lines cannot, and must not, be overburdened in this matter of signals, and must be operated at suitable speeds to avoid such expense.

In other words, the vehicles are to be under control, if a vague technicality may be used, that does duty on railways without any proper definition of its meaning. In pressing the question upon the attention of the existing railways, we do so, fully believing that they will find it remunerative to build such feeder lines, and that if they do not take them in hand the lines will eventually be built by others, whose interest in the railways will be antagonistic; and should this latter event take place, what have only commenced as feeders may very greatly increase, and, to some extent, as has already been done so largely in America, they may even parallel the existing lines, and deprive them of much main line traffic. Indeed, the opinion is strong in America as to the ultimate extinction of steam haulage, unless, we may suppose, for shunting operations; and, though we do not share such opinion as to the extinction of steam haulage for long distance traffic, the possibility will always be with us, and must stand as a menace to the existing arrangements, that will have all the greater force if the feeder lines are held by rivals. We are fully convinced that for these minor lines the system of electrical traction is the system above all others, and that the conversion of country places into habitable localities will be immensely fostered by the influences of better communication; the opportunities of earning a living there will be increased, and the present lamentable depopulation of the country side will be checked.

The soil of this country is far more fertile than that of America, the climate superior, and the country far pleasanter to live in, if we only would make use of its possibilities and cut ourselves adrift from the many obstacles that we have allowed, and still allow, to clog our progress.

ELECTRICAL COMMUNICATION WITH LIGHTSHIPS.

In an article, an abstract of which we reprint a little further on, *Engineering* for last week describes a system of communication by electro-magnetic induction, the apparatus for which is the invention of Mr. Sydney Evershed, and it is stated that this system is to be tried, in the first instance, to establish communication with the East Goodwin Lightship, which lies outside the Goodwin Sands, at a distance of about 10 miles from shore.

The novelty consists solely in the apparatus. So far back as 1892 Mr. C. A. Stevenson suggested that communication should be established between ship and ship by means of induction coils, and on March 19th of last year read a paper before the Royal Society of Edinburgh on "Telegraphic communication by induction by means of coils."

About four months ago we criticised unfavourably a somewhat similar system, which was tried at Sandy Hook by Prof. Lucien J. Bell, and although Mr. Evershed's arrangements seem much superior to this, and his system of calling exceedingly ingenious, we must say that we can scarcely hope that the experiment will result in success. There is something about it which savours more of the skilful and ingenious electrician than of the practical man who has been on board a lightship during a gale of wind and knows what are the conditions to be overcome; and, however well the system may work on land—where, of course, it has been tried—we should be very sorry to have our lives depending on it when in actual use at sea. It may be a matter of life and death at any time, and it is more likely to be so when every circumstance and condition is unfavourable than at any other time.

In the illustration which *Engineering* gives, the lightship is represented as riding to a single mushroom anchor. This is not the usual way in which they are moored, but it is the most unfavourable for the proposed system, and Mr. Evershed has done well in providing for it. The ring of cable encircling the ground over which the lightship might range would probably be about 200 fathoms in diameter, since it is by no means infrequent for a length of 100 fathoms of

chain to be paid out during heavy weather. Apart from the electrical side of the matter, we cannot believe that this ring of cable will not be seriously displaced on many kinds of bottom by the action of the tides. One knows that it does not require a very strong current to move even sharp-edged granite stones, and a cable lying slack on the bottom would probably be moved still more easily.

Then again there comes the expense, which may be taken at more than double that of the system now in use, because, besides the ring of cable more than half a mile in circumference, a double cable to shore is required, and in addition to this there is the length of insulated low resistance wire coiled round the lightship, which would need to be very carefully placed and protected against injury.

We should like to see some experiments made somewhat on the lines of Messrs. Smith and Granville's discontinuous connection which has proved so successful at the Needles, and which we hope will turn out equally well at the Fastnet Rock; or, perhaps, the lightship's chain cable might be utilised as being better than an actual break in the circuit. However, whether Mr. Evershed's arrangement turns out a permanent success or not, the experiment will certainly be of great interest, and afford valuable experience.

Electromotors in Coal Mines.

Against the use of electromotors in coal mines there has constantly been urged the not unreasonable objection that explosions may be started by sparking. Nevertheless, no case of such an explosion is as yet known to have occurred. As has been pointed out, even a dangerously explosive gaseous mixture requires a temperature of at least 900°—1,000° Centigrade in order to initiate its ignition; and the temperature of the sparks from an electromotor must be much lower than this for no oxidation is observed at the collector or the brushes, yet copper begins to oxidise in air at 700° Centigrade. Of course, it may be urged that the spark would not succeed in heating the copper to its own temperature. However, a little reflection makes it clear that at the ends of the brushes, as they become worn, sparks may develop into strong flaming arcs under certain circumstances, for example, when the brushes are shifted or the current strength is altered; so that due caution should be observed. Accidents to the leads are also a source of danger, especially when high potential currents are used. When the conductor is broken, a strong, hot flaming arc may be produced, and this may set fire to combustible gases or matter which may happen to be in the neighbourhood. It is likely enough that such possibilities as these have made people shy of using electricity in coal mines, especially for operating coal-cutting machines which are necessarily situated in the most dangerous parts of coal mines. English dynamo makers have endeavoured to reduce the element of danger by enclosing the collector and brushes in air-tight cases; but mining engineers have felt that this device may prove to be a delusion and a snare. Others, again, have filled the casing with carbonic acid and similar inert gases, and this may meet the case inasmuch as it has been experimentally proved that as little as 14 per cent. of carbonic acid gas within the casing makes an explosion impossible. A writer, in a recent issue of the *Zeits. für Elektrotechnik und Elecktrochemie* (1895, p. 513), urges that polyphase motors without brushes or collector will remove all difficulties that may be apprehended from sparking. He says that there is no danger from breakage of permanent leads if these are properly laid down. In the case, however, of movable or exposed conductors, he points out that every precaution should be taken to obviate danger from breakage sparks and arcs.

Thermochemical Batteries.

An interesting paper was recently communicated to the Paris Academy of Science, by D. Korda, in which he described his researches on thermochemical batteries. He conducted a number of experiments with a view of ascertaining whether in the reduction of metallic oxides there is any development of electrical energy, with the result that he discovered that in only two of the cases investigated there was any distinct electromotive force manifested. He states that barium peroxide, in contact with carbon at a temperature of a dull red heat, gave an electromotive force of about 1 volt. Other peroxides, such as those of manganese and lead, showed no similar behaviour, probably because the product of the reduction process is actually a conductor itself and forms short circuits with the carbon. Copper peroxide and carbon when separated by fused potassium carbonate gave an electromotive force of 0·9 to 1·1 volts, and the curious fact was observed that if the potassium carbonate contains water, the current is at first in the opposite direction, but changes as the temperature rises. In both cases the electromotive force is considerably lower than that calculated from the known thermal disturbances, and it follows that only part of the energy is liberated as electrical energy. Faraday's law does not seem to be applicable, because of the continuous supply of extraneous energy in the form of heat. The paper by Korda may be consulted in full in the *Comptes Rendus*, 1895, cxx., p. 615.

Calcium Carbide and Acetylene.

As our readers are aware, calcium carbide is one of the latest and most interesting of the products which have been obtained from the electric furnace. From it, by means of simple treatment, can be evolved acetylene, a substance which, it is claimed, can be usefully employed for enriching the illuminating power of coal or water gas. Few new products have been so extravagantly and so quickly be-puffed. Possibly the reason of this may be found in the fact that the gas companies recognised in it a means whereby they might solve the hitherto-to-them-almost-insuperable difficulty of raising the candle-power of their illuminant. At any rate they welcomed the advent of acetylene as the advent of a saviour, and the incense of their thanksgiving arose in the land. We are sorry to suggest anything which might have the effect of a disenchantment. Far be it from us to discourage the aged and failing. Yet we feel constrained to warn our *quondam* rivals that all is not gold that glitters, and that they should not proceed to adopt a new thing as an universal *panacea* before they have carefully investigated it. Since calcium carbide was discovered, many chemists have been enquiring into its properties, and it has been found that it is by no means "such a good thing" as was at first supposed. It was claimed that it could be transported almost like coal in truckloads from the manufactory to the place where it would be used; but it is now found that when exposed to the air it changes, crumbling to a grey powder. If it is to be transported without wasting, it must be sealed up in hermetically closed vessels containing coal-oil. Again, the candle-power of acetylene, when burnt at the rate of 5 feet per hour, is 240, whilst that of benzene, according to Frankland and Thorne, is 466. It was expected that coal gas, enriched with acetylene, could be stored in the ordinary gas-holders; but it seems that acetylene dissolves too rapidly in water, and water is always present, not only in the holders, but in the mains and pipes, as well as in the meters most commonly used. The most unfortunate property of acetylene is the avidity with which it attacks brass fittings, and forms a dangerous explosive compound. Finally, statements have been made concerning the advantage of enriching coal gas with acetylene, which have since been discovered to have been born of fertile and eager imaginations, rather than based upon experimental facts. A statement out of which much capital has been made was that as little as 2 or 3 per cent. of acetylene would increase the candle-power of water or coal gas from 16 to 20, producing a clear white light of dazzling brilliancy. This statement is quite groundless. On the other hand, 30 per cent. of acetylene has failed to enrich water-gas to 20 candles. It is clear then that acetylene from calcium carbide has been overrated. If these difficulties can be surmounted, and if calcium carbide can be produced for £1 to £2 per ton, it may be compared to cannel coal at £2 per ton, since about the same quantity of gas is obtainable from each, with an advantage in favour of acetylene as regards its powers of enrichment. These facts are drawn from the following sources:—*Journal* of the American Chemical Society, 1895, xvii., pp. 306—310; *Engineering and Mining Journal*, lix., p. 245; *Bulletin de la Société Chimique de Paris*, 1894, xi., pp. 1002—1007.

THE REDCAR BOILER EXPLOSION.

This explosion, which we commented upon at the time as an example of what is likely to be placed outside the field of ironworks engineering in the future by the success of the gas engine, has been now investigated by the Court, whose judgment against the boiler insurance companies has taken the form of a £50 fine of the National Boiler Insurance Company, on the ground that they did not state with sufficient plainness the danger of boilers 60 feet long and 4½ feet diameter. From the evidence which was tendered at the inquiry, it appears that the Insurance Company wrote to the owners of the boilers in language which was not sufficiently direct, but which, to our mind, should have been amply sufficient to have told any person of common sense that they were running a tremendous risk. True, the Boiler Insurance Company did not discontinue the policy. They knew that if they did so their customers might be offended or annoyed, and so they probably kept on the policy in hopes that their recommendations as to the cutting in half of these long boilers might be followed out to a practical solution, or that the boilers might be replaced by others of safer type and of greater efficiency. The owners of the boilers, Messrs. Walker, Maynard & Co., must have known perfectly well that the continuance of the policy by the insurance company was nothing more than an endeavour to stick to a customer, and they cannot have been so ignorant of the niceties of commercial language as not to understand perfectly well that they were working their boilers under a tremendous risk. The boiler owners are now face to face not merely with the destruction of their works to a large extent, but with possible demands for compensation for life and limb, that will be none the less strong because of the weight of the small fine of £200 levied on them towards defraying the cost of the inquiry, though this fine is supposed to be laid because of the negligence of their engineer who did not urge on the owners the dangerous state of the boiler. The owners have been fined merely as employers of a blameable man, and are freed from culpable responsibility, because, not being engineers, they are graciously allowed to be incapable of understanding a very plain warning. We cannot understand how anyone, with any knowledge of the liability to seam rips in these long boilers should make, work, buy, or insure, any such boiler without some longitudinal bolt stay. True, such a stay is worth nothing as a preventive of seam rip; nothing will prevent that when the conditions are there for its causation, but longitudinal staying will hold the ends of a boiler together while its contents escape through the rip. In these exploded Redcar boilers there would appear to have been no such stays, and while the insurance company were keeping their customer by the use of plain, but civil language, and living in hopes of the advent of new and safe boilers, and the boiler owners were waiting until the insurance company threw up the policy, the boilers solved the question and themselves at the same time by throwing up everything.

The lesson to be learned by engineers in charge of steam plant is to take care to write to their owners and state that they read the report of the boiler insurance company to the effect that explosion is imminent. Owners had better learn that there is risk in not having the capacity of a sixth standard board school boy to understand a smoothly worded warning, while the boiler insurance companies would do well to put their serious warnings in much more direct form. How would it be to have a picture of a boiler explosion on the outside of a large envelope, with the emblems of mortality that usually head a threatening letter, and the words: "This contains a warning that you are running the risk of what the picture represents." All this nicely done in red ink and passed through the village post office, would get round to the owners, even if their engineer were afraid of hurting their feelings, and it would be known to the whole office and every person in the village.

We are not altogether sorry that the fine of £50 has been levied on the National Boiler Insurance Company, even though we place this company high amid its rivals, and may regret that it happens to be the one selected by fate, for all the boiler inspection associations and companies are far too apt to conceal the iron hand under too thick a glove of stuff—we use this word advisedly—and to tone down the simple and direct warnings given them by their own experienced inspectors, who, on their part, might well also speak even more freely in condemnation of what they often find, and of boilers badly prepared for proper inspection. It is hardly to be supposed that an insurance company dare take responsibility where an experienced inspector states he considers a boiler absolutely unsafe, nor that the conveyance of so direct a warning to the owner dare be passed over by him. Indeed, we could give instances where such plain speaking has soon effected a change.

All the same, we cannot see how the National Boiler Insurance Company were so much at fault. Boiler owners will go on for years and take not the slightest notice of recommendations to shorten a safety valve lever by 4 inches to prevent the weight being pushed out upon this surplus length; they will refuse to remove even the few bricks that endanger the blow-out pipe and generally act in a way that makes one suppose they court accident. We know where for years a large firm of boiler owners had some boilers so badly set and ventilated that they never were properly examined for years, and, finally, an inspector set down straight that he refused to take the responsibility of passing them and so they were at last reset on modern principles. However, after this an insurance company can use plain speaking, and, if the boiler owner does remove his boilers to another company, he will not escape should they explode. The usually poor nature of ironworks' boilers is two well known among engineers to require comment. In no other works are boilers so poorly kept and so exposed to all climatic influences as at ironworks.

ELECTRIC STREET LIGHTING.

By GEORGE CUTTER.*

In considering a question like that of lighting streets, alleys, and public squares, we should first define the results to be produced by the lighting system. It appears to me quite simple to define the theoretically perfect lighting, but it is not as easy to decide which system gives results nearest to the theoretical; local conditions affect this question more or less. A general uniform illumination of mild intensity, such as that of a dark cloudy day, or possibly that of a clear night with a full moon, is the theoretical condition to be produced by artificial lighting. This is especially the case after bedtime.

There is an illumination better than either of these two for our study to reproduce artificially, and that is a clear night in winter in extreme northern latitudes. That is, the midnight light of the land a little south of the midnight sun. When we can produce this general uniform illumination of mild intensity most desirable in a town gone to sleep, we will then have the best night illumination. And the rivalry which has led to the use of brilliant effects with really poor practical illumination will be replaced by attempts to produce the best approach to this theoretical condition, and the glare which blinds a man for half a block with accompanying inability to see for the next half block, will become obsolete.

But this mild illumination, while it may be best for the outlying or residence districts during all hours of the night, is not sufficient for the business centre during the earlier hours of the evening. So for proper results we must produce a brilliant illumination of this business centre until bedtime, and for the sake of economy we must then change the down town illumination to the same mild intensity that serves for the residence districts earlier in the evening.

There is one important factor in street lighting which might modify our practice in regard to the best general illumination. It is the police duty of the light in preventing crime and in facilitating the capture of criminals. But even for this duty a uniform illumination of mild intensity is likely to prove best, because the eye which is adjusted to a bright light cannot distinguish objects in a dull light.

There are various points to be considered when we come to the practical side of the question, and try to determine what system will give the best approach to the theoretical

* Abstract of a paper read before the North Western Electrical Association, Chicago, July, 1895.

results with the fewest practical objections. Among these points I might mention a few of the most important:—1. We should consider the means of distribution to produce the nearest to our theoretical conditions; that is, we should aim to procure a uniformity of light, even of mild intensity, in preference to a few extra bright spots with intervening dark spots. An exception can be made, as before indicated, for the business section before bedtime, a brilliant illumination of this section in the early part of the night, changing to correspond with the rest of the city for the rest of the night. 2. Reliability of service of the lighting system, since it loses its effectiveness either as a safeguard as a path finder, or unless it is perfectly reliable. 3. Steadiness of illumination is another point closely connected in importance to the one just mentioned, and in the same line of thought, viz., that of avoiding contrasts in illumination, either in different localities or at different times.

Determining the last two points, brings us to the fourth, necessary skill of all labour and ease of procuring same, the employment of home talent to the greatest extent possible being usually advisable. If the installation and operation of our plant requires special skill, then absence of this skill might cause bad service, or even total cessation of light.

Then there is the durability of the apparatus, together with ease and economy of replacing used up parts. In considering this we must look out for both the probability of permanency of the supply of duplicate parts, and the amount of attention to keep all in good working shape. After careful judging of the closely related points thus far enumerated, we can well give attention to the 6th: Efficiency of conversion from coal pile to light. My only comment on this point is that I place it second in importance to that of general uniform illumination, as high efficiency can well be set aside for the other more desirable feature of uniformity. Considerations of this point of efficiency lead to the 7th: Total operating expenses, the importance of which depends almost entirely upon local conditions, as also the 8th point: Cost of necessary plant for producing the light.

This leads to the 9th: Appearance of fixtures on streets and squares, and on this point more attention should be given than is the usual practice. A large share of the opposition to overhead wiring would never have been raised if it had not been for the bungling work which is so common.

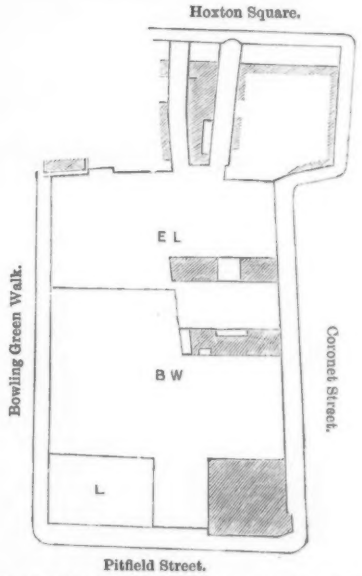
DUST DESTRUCTORS AND ELECTRIC LIGHTING.

I.—Shoreditch.

The Vestry of the Parish of St. Leonard, Shoreditch, has followed the lead of the St. Pancras Vestry in the adoption of a municipal electric lighting scheme, but it has emulated the latter body in becoming pioneers of a movement about which much has been heard, but very little done in reality. The similarity between these two Vestries is, that whereas the latter led the way in adopting a scheme of electricity supply which it kept in its own hands, the former has had the courage to go in for a complete system of combined refuse destruction, electric lighting, thermal storage and steam supply to other municipal ventures with which the electric lighting works will be associated. We do not overlook the adoption of refuse destruction as carried out by the St. Pancras Vestry at their King's Road Station, but there is a considerable difference in the magnitude of the two schemes we are now briefly considering.

Without going into matters of history at length, we may refer to the consideration that was given to the question of refuse destruction as auxiliary to the main steam supply portion of an electric light station. It will be remembered that a report was presented to the Vestry by Messrs. J. B. Alliott, J. M. C. Paton, and H. B. Ransom, some two years ago, in which the probable cost and advantages to be looked for from a combined refuse destruction and electricity supply undertaking were gone into, and this was given in our columns.* Some time elapsed before a further step was taken, and the next movement towards the practical realisation of what had been foreshadowed was the appointment of Mr. Manville as consulting engineer to the Vestry. Mr. Manville's appearance on the scene naturally led to a careful review of what had been done, and to the presentation of further reports. Eventually specifications were issued and tenders asked for, and the Vestry stood committed to what is without question the largest and most important proposal of the kind.

Eleven tenders were received, many of them from well known firms. Some of these estimated that a certain amount of coal would be necessary in addition to the refuse to produce the requisite amount of steam, but others undertook that no coal at all should be used. We imagine that the latter were less cautious than the former, and that this, and not relative superiority or inferiority of plant, explains the difference in the estimate of the steam raising capabilities of refuse. Of the destructors proposed there were several that have been fully treated by Mr. Tomlinson in his articles in our columns. Messrs. Beaman & Deas advocated the furnaces of which an example is to be found at Warrington; Messrs. Fraser & Sons, the Healey furnace; the Horsfall Refuse Furnace Company, the Horsfall furnace; Messrs. Meldrum Bros., Lancashire boilers of the type used at Rochdale; Messrs. Goddard, Massey & Warner, their own furnaces; Messrs. Manlove, Alliott & Co., Limited, the Fryer destructor; and the London Steam Refuse Generator Company, the Livet boiler. In addition to these, a number of adaptations of water tube and Lancashire boilers were offered by other firms, the most important being a carefully-prepared scheme by Messrs. Daniel Adamson & Co.



E L, Electric light station; L, Library; B W, Baths and washouses

After careful consideration, the contract was given to Messrs. Manlove, Alliott & Co., Limited, who had submitted three proposals. Two of these embodied certain of the recommendations which will be found in the report of Messrs. Alliott, Paton, and Ransom. The scheme, as it stands at present, is for a destructor depôt with back-to-back Fryer cells and water tube boilers arranged between pairs of cells alternately. Between the rows of boilers and cells are a pair of longitudinal flues, and the hot gases may be passed into either of these from the cells, or else from the cells through the boilers, and thence into a flue; or some cells one way, and others another. The inclined roadway leading up to the tipping floor, which is to be found in most destructor works, is here done away with, and in its place hydraulic lifts are provided in duplicate for raising the refuse to the level of the upper floor. The means of handling the refuse have been carefully thought out, and seem to foreshadow a great advance upon anything yet attempted.

The dust carts on arrival discharge their contents at ground level into hoppers, which feed small trucks below. These are then raised to the tipping floor by the lifts already mentioned, and are then taken in hand by drag-hoists operated electrically, by which the trucks are drawn along tramways over the charging holes of the cells. This system

* Electrical Review, Vol. xxxiv., p. 604, May 25th, 1894.

is a modification of Mr. H. P. Boulnois and Mr. J. A. Brodie's charging apparatus, which was first devised for use on the Liverpool destructor about 1891.* The use of this apparatus will result in considerable economy in the handling of the refuse, and the space saved by abolishing the inclined road will give additional storage room for the refuse, while the lifts will avoid the wear and tear of horse flesh in pulling loaded waggons up an incline, which is frequently about one in 15, or thereabouts. The fuel is therefore brought up to the charging doors and fed into the cells, the clinkering being done on the ground level. Fire-bars are placed underneath the boilers, so that in case of sudden calls for steam or otherwise coal may be burnt in addition to the refuse, and the direct benefit of the higher class fuel obtained.

The greatest novelty is, however, the use of the thermal storage system, devised by Mr. Druitt Halpin, M.I.C.E.† This system may be briefly described as the accumulation of the energy developed by the boilers at those times of the day when the full amount of steam then generated is not required, and enabling this accumulation to be used at those times when the steam then being raised by the boilers is not sufficient to meet the demand. At first, only a partial use of storage will be made, the surplus heat of the destructor going to heat the feed water in enclosed vessels during the hours of light load, and during the period of greater demand this "hot feed" will be drawn upon by the boilers. With the simple arrangement of destructor, with two cells on each side of each boiler, it was estimated that two tons of coal per diem would be required to make up the maximum amount of steam stipulated for, whereas with partial storage not more than one ton would be used. Partial storage can, in the future, be extended to the complete scheme, and then no coal whatever will be necessary. Prof. Unwin has recently pointed out, in a report on the Halpin system, that a most remarkable result is obtained by its use in the better efficiency of boilers, which, with the same amount of fuel burned in them have an evaporative efficiency at least 15 per cent. better than the same boiler used without thermal storage, and that, again, the water fed into the boiler is practically pure, since most of the insoluble salts contained in hard water are deposited in the storage cylinders, and the boilers, therefore, are put to much less tear and wear, being kept in a highly efficient condition.

Forced draught is to be provided, and it is noteworthy that an extensive use of alternating current motors is contemplated for use in the station, and motor fans in the baths, &c.

In the accompanying sketch plan, we give a general idea of the site upon which the electric light station will be erected. The vestry are about to put up, in conjunction with it, a library, and baths and wash-houses. The roadway entrances lead from Hoxton Square into the space allotted for electric lighting purposes, while the baths and library have their principal *façade* in Pitfield Street.

The areas are as follows :—

Electric light station ...	25,000	square feet,	approx.
Baths	28,000	" "	"
Library	5,800	" "	"

The other boundaries are Bowling Green Walk and Coronet Street. Mr. Rowland Plumbe, F.R.I.B.A., is assessor for competitive designs for the library and baths, which have been asked for from architects. The left hand of the plan is magnetically north, and the dynamos of the electric light station may be placed close to the east boundary of the bath site. It is intended to use the first-class bath as a hall for public meetings and entertainments. Steam for warming rooms, &c., will be supplied from the boilers of the electric light station, and hot water at about 150° F. will also be provided by the same source.

We cannot conclude this preliminary notice of the important scheme now being carried out by the Shoreditch Vestry without referring to the able manner in which it it has been piloted through its initial difficulties by Mr. H. Sawell, the Chairman of the Electric Lighting Committee, and the assistance rendered by Dr. Mansfield Robinson, the Vestry Clerk.

* The first published description was given in a paper on "Refuse Destructors," by Mr. H. P. Boulnois, read before the Liverpool Engineering Society in 1892. *Trans. Liver. Eng. Soc.*, Vol. xiii., p. 125.

† ELECTRICAL REVIEW, Vol. xxxvi., p. 345, *et seq.*

EARL'S COURT EXHIBITION AT NIGHT.

THE most brilliant spectacle in London at the present moment is to be found at Earl's Court. At nightfall many thousand lamps are being utilised to render still more attractive some of the most charmingly wrought surroundings that have ever graced an exhibition. We have previously spoken of the plant that is furnishing energy for a very large number of electric lamps, but the disposition of the lights themselves is, perhaps, still more interesting. The lighting of Queen's Court, which we have depicted in our illustration, is a most creditable achievement, but perhaps the most striking feature is the extraordinary care that has been taken in making the electric light fittings and wiring as substantial as possible. There are no ugly casings, and still uglier metal pipes, to mar either wall or building, the wires being in most cases hidden. The *façade* of the Queen's Court is in pure white, loggias connecting it with the Ducal Palace. It will be seen from our illustrations that the eaves and corners of the buildings, and the loggias, have been picked out with electric lamps, and when the whole of the lights are on the scene is a most brilliant one. There are about 2,000 incandescent lamps in the Queen's Court, exclusive of a few arc lamps that are also used. The incandescent lamps are placed two in series, the mains which feed them being laid underground. In front of the Ducal Palace is the electrically illuminated fountain. The illumination of the fountain is done from beneath the basin, the space here being utilised both for the search lights and transformers for the incandescent lamp circuits. The beam of light from the search lights is usually reflected upwards to the water spray. However, the electrical effects have to be seen to be appreciated.

The lighting of the theatre, which, by the way, is said to be the largest in the world, is exceptionally interesting. The stage lighting is controlled from a platform high up among the clouds. A complete set of choking coils have been fixed up here for the purpose of lowering the lights on the stage battens. By a suitable arrangement of machinery, designed by Mr. Fricker and Mr. Money, the whole of the choking coils can be operated at once, thus lowering the whole of the lights, or the choking coils can be operated singly, thus lowering the lights on one batten.

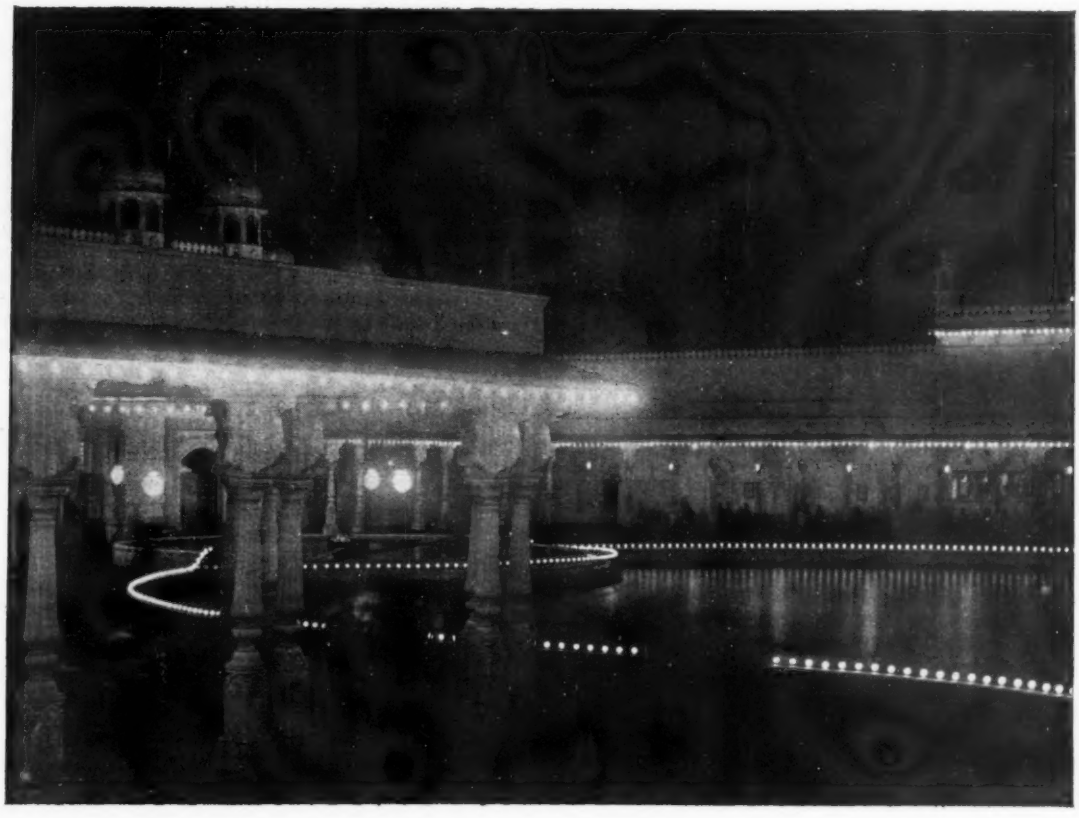
We ought to mention that on the lake, which is in the middle of the ground, there are electric launches which are quite in keeping with the surroundings; these are lighted by small incandescent lamps. They are very largely patronised by the public; and small wonder, for though the journey is short it is very enjoyable.

Of the side shows at the Exhibition, none attracts more attention than that provided by the Electrophone Company. Most of the principal theatres are directly connected with the room of the Electrophone Company, and the facility of hearing the operas now being performed is taken advantage of by the public. On the occasion of our visit, a few nights ago, the hearing was all that could be desired. Mr. H. S. Green, the courteous representative of the company at the exhibition, tells us that on some evenings it is a most difficult matter to accommodate all the visitors. It is interesting to mention that the electrophone is being largely adopted in private houses, clubs, and hotels. The expense of such a luxury is by no means great, it being £15 for the first year, and £10 afterwards; this providing hearing for four persons.

The illustrations have been reproduced from photographs by Mr. Chapman, the press representative at the Exhibition.

ELECTROCUTION.

BY the laws of the State of New York the gallows and hanging for the execution of criminals condemned to death are done away with, and the instantaneous electric current is substituted. This method has been employed in New York State for the past four or five years, and is generally conceded, says the *Scientific American*, to be a vast improvement upon the common hangman's operations. If anything connected with the forcible extinguishment of the life of a criminal can be designated as humane, then the electric process may be rightfully so classed.



Earl's Court Exhibition at Night.

Earl's Court Exhibition at Night.

The most recent case of electrocution is that of a murderer named Buchanan, who was executed at the Sing Sing prison on July 1st.

The *New York Herald* gives a graphic description of the scene, by Mr. W. J. O'Sullivan, from which we make the following abstracts :—

In the case of Dr. Robert Buchanan, who was electrocuted yesterday, every one present was surprised on his entrance. Without the least evidence of fear or bravado he came leaning on the arm of a clergyman, walked to the death chair without the slightest indication of hesitancy, and after seating himself followed with his eyes the process of strapping his legs and arms. There was no tremor of the lips nor nervous twitchings of the hands. To all outer seeming he was calm, and was undoubtedly courageous.

After the strapping was completed, and the leather mask and cap arranged, one of the electrodes was strapped below the knee, the other being in the cap put on the head. At a sign from one of the officials the electrician turned on the electric current, a sudden powerful and intense tonic contraction of the entire muscular system was seen, the body straightened, the legs and arms contracted vigorously, the leather binding straps creaked loudly, the entire surface of the body below the base of the neck blanched, the arms and legs became apparently and were actually bloodless, and Dr. Buchanan was dead.

As much confusion seems to exist relative to the lethal effect of the electric current as employed in electrocutions in this State, it may be of interest to describe the mode of employing the electric force at these executions.

In Dr. Buchanan's case, the first shock was given by a current of 1,760 volts and 8½ ampères. This lasted for 7 seconds, and the current was lowered to 200 volts for 30 seconds, then raised to 1,740 volts for 3 seconds, and again lowered to 200 volts for 17 seconds, when the current was cut off, the whole time during which the current was employed being 57 seconds.

After this current had been shut off, the prison physician, Dr. Irwin, and a very experienced physician, Dr. E. F. Sheehan, of Sing Sing, who has attended nearly all the electrocutions, examined the neck to discover if the carotid arteries gave any indications of pulsating. The body of the unfortunate man emitted two gurgling sounds, with an interval between them. The electrician was instructed to again pass the current through the body, which he did, sending 1,760 volts and 8½ ampères for 3 seconds, and lowering the current to 200 volts for 20 seconds, when the current was shut off entirely.

The body was then examined by nearly all the physicians present, to determine if the faintest heart beat could be detected, and the consensus of opinion was that life was extinct, as the writer verily believes it was. After this examination the body was placed on the autopsy table.

To many, the terms volts and ampères convey but an indistinct idea of the potency of the agent used to induce death, and the haziness of this idea has been materially increased by horror mongers who have exploited themselves recently through the press, the most noticeable feature of their lucubrations being the absence of the elements, knowledge, or disinterestedness.

If the reader will regard the voltage as the speed or velocity of the current, and the ampèrage as the mass or volume of this same current, he will glean through this imperfect parallel some idea of what is meant. It is strange that those who have discussed this matter in the daily papers either wittingly, or unwittingly, avoid mention of the ampèrage, without which no estimate can be formed of the potency of the current or its energy. A locomotive and a bee may travel at the same rate of speed, say, 20 miles an hour. That speed would, in the case of electricity, be the voltage. Should a person come in collision with the bee little damage would ensue, though the obverse would be the fact in the case of the locomotive. Wherein lies the difference, both having the same speed or voltage? It lies in the volume of the mass or body of each. This would be the ampèrage in the case of electricity, and if we multiply the speed or velocity by the weight or volume of the mass or body, we get the striking force, or what is termed in the case of electricity a watt, which is defined as the unit of energy or working power.

Fearing the foregoing very simple fac-simile may not be sufficiently lucid, we can measure this energy by a better and more accurate method. Taking the current employed on Dr. Buchanan, 1,760 volts, 8½ ampères. If we multiply the former by the latter, we have 1,760 × 8½—equal 14,960 watts. Now it has been demonstrated by electricians that 746 watts equal 1 horse-power. If we divide 14,960 watts by 746 watts, we get the potency of the current employed to kill Dr. Buchanan as equal to 20 horse-power. Such power suddenly liberated in a human body can have but one result —to kill. It did kill, the death being sudden and painless.

In relation to the two gurgling sounds emitted, and which have been and will be magnified and exaggerated by caterers to the morbid and gruesome, it will only be necessary to recall to the reader's mind the fact that death by electricity is by asphyxiation, or as it is more popularly known, by suffocation, a death similar in this respect to one from drowning or strangulation, &c.

CORRESPONDENCE.

Alleged Mis-statements at the Gas Light Company's Meeting.

In the article headed "The Gas Light and Coke Company and the Electric Light," in your issue of 9th inst., a Mr. Fraser is reported to have made remarks which must not be allowed to go unchallenged. If he has followed the question of lighting at Brighton and Hove so closely as he states, he must know that the Hove authorities have *not* decided to adopt the incandescent gas system for the remainder of the lighting. He will more likely find, if he follows the question a little "closer" still, that the few lights of the kind tried by the authorities will "very closely" follow the other gas lighting, and be replaced by electric light.

It would be interesting to some of us ratepayers here to know what the "enormous expense," which Mr. Fraser refers to, has been incurred in; it is certainly not in the electric lighting of the streets. Of course, it may have been in the up-keep of the half dozen or so incandescent gas lights which have been on trial; if so, this quite justifies the authorities in not extending them. The mantles are not only at the mercy of every breeze from the sea, and every man finding his way at night who happens to fall against the lamp-posts, but it is whispered that those mantles on trial, after failure, are in many cases being replaced surreptitiously, so that the full cost of the up-keep is not made known.

As to Brighton, well, the least said about this by the supporters of incandescent or other gas, the better for their case, as it is now well known what a success electric lighting has been there, and the Corporation are erecting another 120 arc lamps in the streets to replace gas. It is also proposed to substitute electricity for gas in the markets, &c. If this is satisfactory to supporters of gas, then I think they are welcome to the consolation, and electrical engineers are not at all dissatisfied with the progress.

Such statements as that credited to Mr. Fraser only show the depths to which it is possible to fall in the endeavour to bolster up a weak and failing cause.

B. H. Jenkinson.

August 12th, 1895.

A "Plant."

Kindly inform me what sort of flower an electrical plant bears, and how they are propagated.

Botanist.

[The bearings are generally "current" flowers, *Rubus Dynamicus;* they have been mostly propagated by "cutting." —Eds. Elec. Rev.]

Provisional Orders.

Providing I obtained permission from the local authorities to cross the roads with wires for *private* lighting only, would it be necessary for me to also get a license or provisional order to do this? An answer will greatly oblige.

G. A. Ellis.

[We have often pointed out that under the above conditions no license or order is necessary.—Eds. Elec. Rev.]

ELECTRIC COMMUNICATION WITH LIGHTSHIPS.*

Several lightships have been put in electrical communication with the shore, and a trial is to be made of the inductive system, in which the cable lies wholly on the bottom of the sea, and the signals are transmitted over the intervening space to the apparatus on board by electro-magnetic induction. The apparatus to be used is the invention of Mr. Sydney Evershed, and its principle is illustrated diagrammatically in the annexed illustration. Fig. 1 shows a lightship, B, able to swing round a mushroom anchor. Around the circle which it is capable of occupying there is laid, on the sea bottom, a ring of cable, A, connected to the shore station, as shown. A secondary coil is fixed on the ship, and should consist of, at least, 50 turns of insulated wire, of as low a resistance as possible. If the ship is built largely of iron, the secondary coil should be arranged around the outside of the bulwarks; its magnetic axis must be as nearly as possible normal to the plane of the ship's decks. Interrupted currents are sent through the submarine cable by means of a key, K, and a contact-breaker, W, driven at such a speed as to interrupt the current several thousand times a second. The discontinuous currents in the cable ring, A, produce rapidly alternating electromotive forces in the secondary coil, and alternate currents pass through the telephone, T, and indicate their presence by the buzzing of its diaphragm. The signals are read by the Morse code. The difficulty with inductive telegraphy lies in calling the attention of the operator, as, of course, he cannot live with the telephone at his ear. This difficulty appears to have been removed by Mr. Evershed in an exceedingly ingenious manner by the invention of a cumulative impulse relay, illustrated in fig. 2. A rectangle of wire, V, is clamped in an insulating support, I. One side of the rectangle is placed between the poles N. and S. of a powerful magnet, and when the rectangle is traversed by alternating currents, timed to correspond to its frequency of vibration, it receives a series of cumulative impulses, and is set in vibration. This vibration brings it against a contact on the similar rectangle, P, which is tuned in unison with V. When the two touch, the circuit of a local battery is closed, and a bell rung. The two similar rectangles are used to prevent accidental contact due to mechanical jars. The second rectangle may be traversed by alternating currents in the opposite direction to the first. The currents employed in calling are not the same as those for speaking. A frequency of 20 to 40 periods per second is suitable, and is obtained by means of a tuning fork or other similar device. The vessel on which the induction telegraph is to be tried in the first instance is the *East Goodwin*, which lies outside the Goodwins, and will require a cable of some 10 nautical miles in length.

Fig. 1.

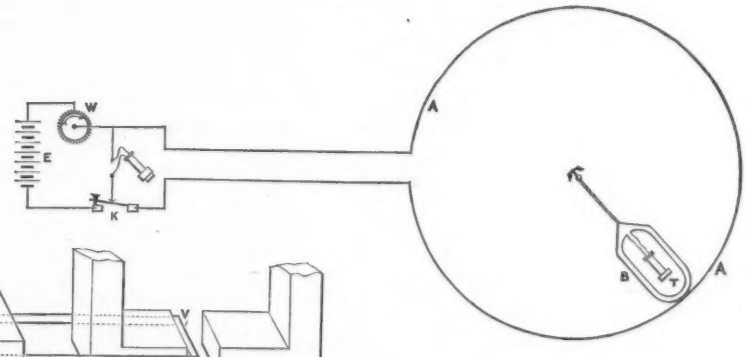
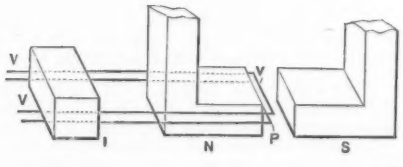


Fig. 2.



* Abstracted from *Engineering*.

LEGAL.

Consolidated Telephone Construction and Maintenance Company, Limited.

On behalf of this company, Mr. Farwell, Q.C., on Saturday last, presented a petition to Mr. Justice Chitty, sitting in the Chancery Division of the High Court of Justice, for his consent, under the Companies' Act of 1890, to an enlargement of the objects of the undertaking as at present defined in their Articles of Association. The original object of the company might be briefly described as the manufacture of apparatus connected with telephones, and to carry on the business of telephone and telegraphic manufacturers, with the maintenance of telephone and telegraph lines; they, however, found not only that their manufactures had become less lucrative than formerly, but that their present trained staff of workmen was only partially employed, and with their existing capital they could advantageously combine and easily enlarge their operations to also making apparatus for scientific and mechanical instruments of all kinds. They, therefore, proposed to add to the existing clause defining their objects a sub-clause enlarging their powers, and altering the name of the company from that of "Construction and Maintenance" to "Construction and Manufacturing."

Mr. Justice Chitty: A rather sweeping addition, isn't it?

Mr. Farwell said it was intended not so much to alter the nature of the company's aims, as to make them wider, and he thought his Lordship would agree with him that it would not have been a great stretch of the powers they already possessed if they had undertaken the additional kind of work now proposed without coming to the Court, but they preferred following what was, obviously, the safer course in the matter, and following, as they thought, the spirit rather than the letter of their responsibilities. They had communicated with the Board of Trade, and passed all the formal resolutions necessary to the attainment of their desire, and the only debts due to creditors was about the normal sum of £757.

His Lordship, having perused the papers filed in the case, said the matter appeared straightforward enough, and, on compliance with the customary formalities and requirements, his consent would go.

British Insulated Wire Company, Limited v. The Fowler-Waring Cables Company, Limited.

In this action, application was made to Mr. Justice Kekewich, sitting in the Chancery Division, just before he rose for the Long Vacation on Friday afternoon, for an injunction restraining the defendants until the trial, or further order, from infringing the plaintiffs' letters patent relating to improvements in electric cables or conductors, particularly such as are intended for use in telephone transmission. The nature of plaintiffs' invention was described as an electric cable or strand, consisting of two or more conductors, each being separated from the other by a strip of non-conducting material, the conductors and non-conducting material being twisted together, so that spiral air spaces are formed in which the conductors lie—the aim being the reduction of the capacity to the utmost degree as highly advantageous, and by means of comparatively large air spaces, simplifying obstruction and obtaining compactness.

Mr. Graham now said it had been arranged that the action should stand over the Long Vacation, defendants giving an undertaking to keep an account; and to this course his Lordship assented.

Bristol Tramways.—The report of the Bristol Tramways and Carriage Company, Limited, says that the construction of the City to Kingswood Electrical line, and the conversion of the St. George's Depôt into a power station, are approaching completion, so that the tramway will be open for public traffic within a few weeks.

O

BUSINESS NOTICES, &c.

Agency.—Messrs. Hodges & Todd, of Hampstead Road, London, have appointed Messrs. Wm. McGeoch & Co., of 108, Argyle Street, Glasgow, their sole agents for Scotland, who will, in future, keep stock of their instruments and specialities.

Alternators.—That Messrs. S. Z. de Ferranti, Limited, exercise exceptional versatility in the construction of high class alternators, is evident from the quantity of work they have at present in hand or have completed for the following towns:—Edinburgh—Alternators with iron cored stationary armatures direct coupled to *high speed* engines at 450 revolutions per minute. Portsmouth, Southport, and Islington—Alternators with iron cored stationary armatures direct coupled to *slow speed* horizontal engines at 96 revolutions per minute. Hanley, Huddersfield, and Sheffield—Alternators with "coreless" revolving armatures direct coupled to *moderate speed* vertical engines at 150 revolutions per minute. Bolton—Ditto, ditto, 156 revolutions per minute. South Shields—Ditto, ditto, 120 revolutions per minute. The alternator is thus specialised in the hands of a first class maker, and is adapted to the character of each of the three popular types of steam engine, high, moderate, and slow speed. The following is a note of the rectifiers the company has supplied or has at present in course of construction. Already supplied:—Portsmouth, 4 rectifiers; Cardiff, 4; Blackpool, 1; Tunbridge Wells, 2; Edinburgh, 3. In course of construction:—For Islington, 5; South Shields, 2; Southport, 2; Hanley, 1; Portsmouth, 4.

Bankruptcy Proceedings.—The first meeting of the creditors interested under the failure of Ronald A. Scott, electrical engineer, The Elms, Acton Hill, was held on Wednesday last week at the offices of the official receiver, Temple Avenue, E.C. The statement of affairs filed by the debtor disclosed gross liabilities amounting to £10,787 2s., of which £3,832 2s. was due to unsecured creditors. To fully secured creditors £4,180, the value of the securities being estimated to produce £10,000, thus showing an estimated surplus of £5,820. To partly secured creditors £2,775, the value of the securities being estimated at £450, leaving a balance of £2,325 to rank against the estate for dividend. The total liabilities expected to rank for dividend amounted to £6,157 2s. The assets consisted of the estimated surplus from securities in the hands of fully secured creditors, valued at £5,820, thus leaving an estimated deficiency of £337 2s. The report and observations of the official receiver were to the following effect:—The receiving order was made upon the petition of Ernest George Meers, trading as Watts & Co., at 24, Leadenhall Street, E.C., gum merchants, and Henry Edmunds and Godfrey Blundell Samuelson, of 39, Victoria Street, trading as W. T. Glover & Co., electrical engineers, the act of bankruptcy being the non-compliance by the debtor with the requirements of a bankruptcy notice duly served upon him. The debtor states that he has now no business. In 1889 he commenced to carry on business as an electrical engineer, at The Elms, Acton Hill, with a capital of about £900, and he continued that business until June, 1894, when it was formed into a limited company, under the style of Ronald A. Scott, Limited, with a nominal capital of £10,000, divided into 10,000 shares of £1 each. The objects of the company among other things were the purchasing or otherwise acquiring the business, goodwill, machinery, rights, privileges, and other property of the bankrupt, the carrying on of the business of electricians, engineers, electrical engineers, and general contractors, and such other business as the company might from time to time determine, the purchasing or otherwise acquiring any real or personal property necessary or convenient for the purposes of the company, and any estate or interest, or interest therein. The debtor states that the consideration for the sale was that he should receive £5,000 in fully paid up shares, and these were dully allotted to him. The debtor acted as manager of the company, and on December 6th last, on the application of the debenture holders, Mr. P. T. Travers, of 17, Ryder Street, St. James's, S.W., chartered accountant, was appointed receiver. The debtor further states that the receiver carried on the business until May last, and since then it has been practically closed. The debtor for his assistance received £5 per week for some weeks, and afterwards £4 per week. The books used in connection with the business are in the hands of the receiver. The unsecured creditors number 120, and are chiefly owing for goods supplied, but there are two cash creditors for £1,060 and £199 2s. 6d. The creditor stated to be fully secured holds a mortgage on two English patents, and the debtor states that the patents are worth £10,000. The creditor stated to be partly secured holds a mortgage on lease and household premises. The debtor attributes his present position to bad trade for the past three years, and competition, also to losses in bringing out advertising patents. After Mr. Mercer, the senior official receiver, had read over the proofs of debt lodged, he stated that although there were a fair number of creditors present, no resolutions could be passed, as the proofs were not lodged in time to vote at that meeting, but the debtor was present and they could question him if they liked. The debtor in reply to questions said the company was formed in June, 1894, and since then he had contracted debts as Scott, Limited. With regard to the assets he did not think he assigned the patents to the company. Scott, Limited, took over the liabilities of "Mr. Scott." The official receiver remarked that the debtor seemed to have occupied a dual capacity, similar to "The Strange Case of Dr. Jekyl and Mr. Hyde." With regard to the company, there were no shareholders beyond the debtor and the seven subscribers to the memorandum and articles of association: there were no directors, and no secretary. The whole thing seemed to be bound up in Messrs. Reeves, the debtor's solicitors, who had formed the company. The debtor said he did not think the original agreement with the vendors had been registered at Somerset House. He had assigned the lease of his house to the company. He had raised £5,000 debentures on the company, but they were now in the hands of creditors. A creditor stated that he understood that the shares allotted to debtor had only been formally allotted. The debtor said there were share certificates for the 5,000 shares in his name, but he had never had them in his possession for more than half-an-hour. As a matter of fact, they had never been out of Messrs. Reeves' office. The official receiver said he had not been able to look into the affairs of the company at present, but it seemed to him that the company could be determined by order of the Court. At any rate as far as he could see the debentures were clearly bad. The debtor further stated that when the company was formed, Messrs. Reeves & Sons acted as his solicitors, and they also acted for the debenture holders. £1,000 worth of debentures had been assigned to Messrs. Reeves, but that was not in respect of law costs. The debentures were not given for advances made after the formation of the company, but they were given as security for advances made to him by Mr. and Mrs. Breeks, before he turned himself into a company. The loans from Mr. and Mrs. Breeks had extended over a period of two or three years. They were unknown to him, until introduced to him by Messrs. Reeves. The monies were chiefly advanced for the purpose of buying machinery. When he took "The Elms" he had a capital of £1,000. A long discussion then followed as to the position of the debtor towards the company, in the course of which the official receiver said the debtor had apparently assigned everything to the company, including "large and small forks, wardrobes and other bedroom furniture, the drawing-room carpet, and even the kitchen utensils and oilcloth." All were assigned to the company. The debtor in answer to further questions said Messrs. Siemens were the licensees of one of his patents for an electrical projector, which had been used at the Crystal Palace. They were paying the patent fees in connection with the patent, so he presumed it was worth something. He had assigned patents to various people, but up to the present had not received anything for them. Eventually the official receiver said the meeting had better be adjourned, and it was accordingly adjourned for six weeks.

Changes of Address.—Owing to pressure of work, Messrs. Russell & Lennard are removing their offices to more commodious premises, and from 14th inst. their sole London address will be 135, Victoria Street, Westminster, S.W.

Messrs. Conze & Simon, wholesale purveyors to the electrical trade, have removed their offices from 37, Queen Victoria Street, to No. 52, Queen Victoria Street, E.C.

House Lighting.—The Tayler Smith Electric Company, Limited, are carrying out the installation of 6, Roland Houses for Admiral Sir Windham Hornby, K.C.B.

Johnson & Phillips.—This firm is very busy, and has in hand the alternators for the Cape Town and Suburban lighting mentioned in our South African notes last week, the transformers for the Portsmouth extensions, the St. Helens alternators and exciters, and another diphase transmission of power plant to deliver 120 horse-power at a distance of five miles for the Barberton district.

Outings.—On Saturday, the 27th ult., the *employés* of Messrs. Rashleigh Phipps & Co. went for their annual outing to Ramsgate. Dinner was served at the Cannon Inn, after which there was a drive through Pegwell, Birchington, Margate, and other places. This firm have recently received instructions to carry out the electric lighting of Lord Dudley's new mansion, No. 7, Carlton Gardens. They are at present busy with a large number of private installations in the West End of London and elsewhere.

Partnerships.—Mr. G. L. Addenbrooke informs us that he has taken Mr. Ernest Scott into partnership. Mr. Scott served his time with Messrs. J. Fowler & Co., Limited, of Leeds, and was afterwards with Messrs. W. T. Goolden & Co., and the Brush Company, while for the last year he has been head of the drawing office department at the Electric Construction Company's works. Letters to the firm (Addenbrooke & Scott) should be addressed to 21, Lichfield Street, Wolverhampton, but Mr. Addenbrooke will be frequently in London as heretofore.

We are asked to state that Mr. William Heath Merriman, A.I.E.E., has joined the firm of Slade, Templeton and Co., telegraph and electrical engineers and contractors for the complete equipment of cable laying and repairing steamers, and the firm contemplate enlarging and extending their business.

Smoke and Fumes Annihilator Company, Limited.—On Tuesday, September 17th, at 2 o'clock p.m., a general meeting will be held at Cannon Street Hotel, to receive an account of the winding up.

The Synchronome Company.—Mr. F. Hope-Jones informs us that he has severed his connection with the Hope-Jones Electric Organ Company, Limited, in order to introduce the synchronome system of electric clocks. This system is the result of some years of study and experimental work by Mr. G. B. Bowell and Mr. Hope-Jones. Their aim has been to dispense with the complicated mechanism of the ordinary clock, and at the same time to secure reliability and timekeeping qualities never before attempted. In this they claim to have succeeded as completely as Mr. Hope-Jones's brother has in his revolution of organ building. It is Messrs. Hope-Jones and Bowell's intention to introduce the system through the trade under the style of the Synchronome Company, but for the present they are prepared to fulfil orders themselves in accord with price lists which they have issued and of which we have received copies.

ELECTRIC LIGHTING NOTES.

Bangor.—Mr. Medhurst recently presented his amended report and estimate of proposed electric lighting works. The cost was put down at £13,000. After discussion, the City Council referred the matter back, thinking it would be better to look further into it.

Belgium.—For the contract for the supply and erection of plant for the electric lighting of the Schærbeek and Nord Railway Station, for the Belgian State Railway authorities, eight tenders, in all, were submitted, the lowest being that of Messrs. Mulmann and Forkel, of Brussels, who quoted 50,300 francs (£2,012); the highest tender was £4,564.

Blackpool.—The following minute of the Electric Lighting and Tramway Committee came before the Council last week:—"On July 23rd, this committee accepted the resolution of the Highway Committee, that in view of probable future extensions of the Corporation's electricity works, all the central store yard land between West Caroline Street and Princess Street, in the Highway Committee's department, should be transferred to the Electric Lighting department, on terms to be arranged by the Mayor, the chairman (Alderman Cardwell), and Councillor Pearson."

Cardiff.—Upon the occasion of a ball at Boddington Manor last week, the buildings were lighted by electricity by Messrs. Knapman, Hodder & Co., of Cardiff.

Coventry.—The City Council on Tuesday considered what price to charge for electrical energy. 6d. per unit is to be charged up to a certain amount.

Derby.—"The tender of Mr. Geo. Wagg (£1,965) for building boiler seating for the three new boilers, and for building a new coal store at the central station, has, subject to the approval of the Council, been accepted. Assuming that £2,000 for mains is sufficient, the further sum of £524 will be required to complete the works ordered by the Council, who were asked to grant that sum. In consequence of the increasing demand for electricity, the Committee have under consideration the desirability of enlarging the present station, and asked the Council to grant £3,490 for building an annexe, providing a 250 horse-power engine, and other works." This report of the Electric Lighting Committee was agreed to by the Council after discussion. It was also resolved to inquire into the full details of the arrangement at present existing between the Council and Messrs. Bramwell & Harris.

Dundalk.—The present lighting of the town being unsatisfactory, the Town Commissioners are to re-open the electric lighting question.

Dundee.—At a recent meeting of the Gas Committee it was reported that the rental for the quarter ended July 31st amounted to £6,844 9s. 8d., as contrasted with £6,847 12s. 10d. for the corresponding period last year, a decrease of £3 3s. 2d. The electricity rental amounted to £407 13s. 11d., against £408 17s. 9d., a decrease of £1 3s. 10d. In the estimates for the current year, the electric lighting of High Street is set down as £200.

Germany.—The Allgemeine Electricitäts Gesellschaft, of Berlin, is about to commence the erection of a large central station at Oberschonweide, near Berlin, for the electric lighting of Telton and Niederbarnim. A central electric lighting station is approaching completion at Floha.

Halifax.—Electric cables are to be laid up Parkinson Lane, and the committee will ask the Council at its next meeting to authorise an expenditure of £11,000 for supplying the electric light to the district of Skircoat. The committee have decided to purchase five arc lamps and cast-iron pillars and brackets for erection in Silver Street, Crown Street, and Old Market, at a cost of £95.

Hampstead.—On Wednesday, last week, for the first time, the town clock at the Fire Brigade Station was lighted by electricity. The three faces of the clock are now lighted by four 12 C.P. incandescent lamps. The work has been carried out by Mr. William Thompson, of Heath Street.

Hastings.—The Hastings and St. Leonards-on-Sea Electric Light Company, having given notice of its intention regarding laying mains, constructing inspection boxes, &c., the Council has given its consent conditionally.

Hull.—A Sub-Committee has been appointed to consider the question of advertising for a new electrical engineer to take the place of Mr. A. H. Gibbings, who, as we have already stated, is leaving for a similar post at Bradford.

Leyton.—At a recent meeting of the District Council, the following report of the Electric Lighting Committee was adopted:—"Your committee have had under consideration the reports of Prof. Henry Robinson, as also the resolution of the Council approving the scheme, as thus set out in the last-mentioned report, as amended after consultation, viz.:—Land, £600; buildings, £1,000; central station plant, including two engines and dynamos, £4,000; five miles of mains, £8,440; meters, house connections, &c., £300; 150 public lamps, £450; contingencies, £1,410; total, £16,200. Annual working expenses, as amended after consultation with committee:—Staff, £500; maintenance, £100; capital charges, £946; £26 for land; fuel, stores, &c., £500; total, £2,072. Annual revenue:—Public buildings (for the first year or two), £406; 150 public lamps at £3 4s. 7d. per lamp, £484; private lighting, 2,230 lamps installed at 6d. per unit, £1,390; total, £2,280. Your committee have met Prof. Robinson in consultation, and inspected with him the process of gas manufacture (as recommended) in connection with flour mills at Chelsea, and in connection with the gas engines for electric lighting at the Midland Railway Company's station and goods yard, Leicester, and having carefully considered the practical working of the scheme, your committee have no hesitation in recommending the Council to give effect to the resolution already passed, and to authorise the speedy carrying out of the work proposed. The necessity of providing electric light to the new public offices and Technical Institute renders it desirable that steps should be forthwith taken for preparation of plans, specifications, and estimate for submission to the Local Government Board in order to obtain the necessary sanction for loan to cover the outlay, and your committee recommend that Prof. Robinson be instructed to prepare the plans, specifications, and estimate, and that application be made to the Local Government Board for sanction to borrow £16,200. The additional amount includes the extension along the Leytonstone Road and additional cost of land, as shown by amended statement, beyond that first proposed. The cost of the Leytonstone Road extension is estimated at £1,750."

The following report of the Hall Building and Electric Lighting Committee was also adopted:—"They recommend that Prof. Henry Robinson be instructed to prepare plans, specifications, and estimates, and that tenders be invited from not less than twelve electrical firms, to be selected by Prof. Robinson, to be opened at a special meeting of the Council to be convened early in September next."

Liverpool.—The City Council again last week had a discussion regarding the report of the Lighting Committee in the matter of the purchase of the Electric Supply Company.

Manchester.—The City Council are to purchase several acres of land adjoining the electric light station in Dickinson Street, on the recommendation of the Gas Committee.

Montrose.—The Caledonian Electric Supply Company has given notice to the Council of its intention to apply for a provisional order.

Morecambe.—An extraordinary general meeting of the shareholders of the Morecambe Electric Light and Power Company, Limited, was held on Saturday evening, to receive and consider a statement of the company's affairs prepared by the secretary. After this had been discussed, it was resolved unanimously that the directors be empowered to treat with and enter into a binding agreement with the Morecambe Urban District Council, or any other intending purchaser, for the purchase and transfer of the company's undertaking and property on the most favourable terms.

Salford.—The electric lighting works of the Corporation, which are situated in Walness Road, Lower Broughton, were formally opened on Wednesday evening last week by Councillor Holland, the chairman of the gas and electric lighting committee. Mrs. Holland switched on the current in the presence of the Mayor and Mayoress, and many others.

Ship Lighting.—A few days ago was launched on the Clyde a steel screw steamer, *Lizard*, intended to ply between London and Glasgow, for the Clyde Shipping Company. The vessel is lighted throughout by electricity, the work having been done by Messrs. W. C. Martin & Co., of Glasgow. There are 158 16-C.P. lights, and two cargo clusters of 400 C.P. each. A direct-driven dynamo, with an output of 250 ampères at 60 volts, supplies the current.

Sunderland.—The Town Council have, by 19 votes to 18, decided that as the electric light undertaking is at present working at a loss, they cannot increase the salary of Mr. Vesey Brown, the electrical engineer, from £200 to £260 per annum as requested. Mr. Brown asked for the advance on account of extra work in connection with extensions which had been carried out.

Totnes.—On the occasion of a Fancy Fair at Totnes, the electric light was used for decorative purposes, two 500-C.P. arc lamps being lighted from a "Taunton" dynamo.

Wells.—The Mayor reported at the last Council meeting that the documents had been returned from Messrs. Davis & Roach on the electric lighting matter, but they declined to give the name of the electrician they desired to introduce to take up the matter where Mr. Dixon Browne had left it. Letters were read from several electrical engineers offering their services as consulting engineers, and some discussion ensued, the desirability of the Council doing the needful work themselves under the best advice they could obtain being unanimously assented to, and the matter of selecting an engineer to advise the Council was left to the Lighting Committee.

Weybridge.—The District Council recently decided not to buy up the works of the Electric Light Supply Company. Subsequently, however, Mr. Spagnoletti, by invitation of one of the members, made, by permission, a statement regarding appliances which would be required, and the probable cost of maintenance. Mr. Spagnoletti was asked to prepare a scheme and estimate, and his report was read at a meeting of the Council last week. Under this scheme, the whole cost of taking over the present works and laying down new machinery will amount to something over £8,000. The matter is receiving consideration.

Wigan.—There was a discussion at the last meeting of the Council regarding the Electric Lighting Committee's delay in electric lighting matters, one speaker remarking that he was afraid the "electric light was snuffed out for the present." It was hoped that the discussion would have a revivifying effect.

York.—At the last City Council meeting it was recommended that the offer of the Electric Construction Company, Limited, for the supply of the first instalment of plant be accepted, together with their offer to run the plant for a period of seven years. The amount of the tender was £8,650, with an addition of £6,000 outlay for buildings, &c. The Council, however, referred the matter back, and instructed the Committee to agree upon an expert to report as to the best mode of electrically lighting the city, advertise for tenders, and report.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackpool.—The Town Council last week had to consider the following minute of the Electric Lighting and Tramway Committee: "On the 25th, it was resolved that a sub-committee, consisting of the Mayor, the chairman (Coun. Pearson), Aldermen Buckley and Bickerstaffe, and Councillors Heap and Smith, be desired to consider and report upon the best means of working electrically the Lytham Road tramways, south of Station Road."

Derby—Ashbourne Proposed Electric Line.—A public meeting was held at Derby on 9th inst., when the scheme for the construction of a light electric railway on the overhead system from Derby to Ashbourne was considered. The line, it is contemplated, will be connected with the existing Derby tramway, which terminates on the Ashbourne Road. Thence it will run through Mackworth, Kirk, Langley, and Brailsford into the town of Ashbourne, terminating near the bridge. It was suggested that the line should be laid on the western side of the road, through nearly the whole length, but through villages it will run in the centre of the road. The present railway journey from Derby is by a very circuitous route, occupying on an average about 1¼ hours, whereas by the new line it is expected the distance would be covered in 75 minutes. A rough estimate of the expenditure, including the cost of permanent way, materials, laying, &c., together with lands, building, and rolling stock, was placed at £62,300. A committee was appointed consisting of Messrs. Newton, Meynell, J. Smith, T. O. Farmer, Bradford, Murray, L. M. Edwards, W. H. Tomlinson, R. Turner, Pakeman, and W. R. Holland to discuss the details, obtain further information, and report to a future meeting.

Dublin Tramways.—The Rathmines Commissioners the other day again talked over the proposed electric tramway system and the opposition thereto. Mr. Carey gave a brief account of the experience derived by the deputation. They visited Blackpool, Leeds, and other places, and were strengthened in their belief that the overhead system was most unsightly and objectionable.

The report of the Imperial Tramways Company says that the working of the Dublin Southern District Tramways Company's lines is not to be expected to afford any proper comparison with the previous years, inasmuch as the traffic has been seriously disorganised by the electrical reconstruction works in progress. Traffic had to be entirely suspended on the Dublin to Blackrock section on March 11th—thus disconnecting the track from the Dublin United Company's system—and also upon the Blackrock and Kingstown section on June 11th. Since the latter date the line between Kingstown and Dalkey—two miles—has been the only part of the system in traffic. The contract for the electrical reconstruction of the tramways provided for the completion of the portion from Dublin to Kingstown by May 1st, and from the last-named to Dalkey by July 1st, but the contractors have found themselves unable to effect the works within the stipulated periods.

Electric Traction in Brussels.—The system of electric tramways in the Belgium capital has just been extended by the completion of a line between the Gare du Luxembourg and the Gare du Midi. The line, which is on the overhead conductor system, was opened for traffic on the 1st inst.

Electric Traction in Germany.—An electric tramway is about to be constructed in the suburbs of Berlin to connect Rummelsburg, Köpenict, Friedrichshagen, Grunau, Oberschönweide, Niederschonweide and Trepton. Plans have been prepared for an electric tramway between Leipzig and Valle. The plans for the projected electric tramway between Braunschweig and Wölfenbuttel have now been completed and submitted to the local authorities for approval. The line will be on the overhead conductor system.

Electric Traction in Russia.—It is reported that a contract has been given to the Oerlikon Maschinenfabrik, for the construction of a network of electric tramways in the town of Nijninovgorod.

Electric Traction in Switzerland.—It is proposed to construct an electric tramway between Zurich and Fahrnangen, *via* Bremgarten and Wohlen. A proposal to construct a line between Locle and Brévine is also under consideration. An electric tramway is to be constructed between Lugano and Cassarate. Plans are being prepared for quite a number of projected electric tramways, including a line between Schwanden and Elm, one from Bruggen to St. Fiden *via* St. Gall, one from the Wengernalf to Eigei, one from Aigle to Leysin, and one from Lugano to Ponte Tresa.

Electric Traction Wanted in Norway.—The New York *Electric Railway Gazette* (until recently known as the *Street Railway Gazette*) says that an electrical engineer in the service of the Norwegian Government (Mr. Einar Rasmussen, of Christiania) is at present in New York investigating the matter of the electrical transmission of power in the United States. The Government, which owns almost all the railways in Norway, wants to determine to what extent it will prove advantageous to operate them by electricity. An abundance of water power is available for the generation of electricity, but in some instances it would be necessary to transmit the current for considerable distances. If any plan for the electrical operation of roads is adopted it will involve the use of water power almost entirely, because one of the chief reasons which prompts the government to consider the question of making the change is a desire to escape the necessity of procuring coal. The country, while rich in water power, is entirely without coal mines and the supply must be imported. At the time of the great coal strike in England, the supply in Norway ran so low at one time that it was questioned if it would not be necessary to discontinue, to a very considerable extent, the railway service of the country. The government hopes to be able by utilising water power to escape such a predicament. "The entire dependence on foreign supply which now exists is not flattering to the national pride. Mr. Rasmussen will probably visit all the large stations in the country where current is carried at high potentials."

Glasgow Tramways.—According to a Glasgow paper, the Glasgow Corporation are considering the question of the application of mechanical power in connection with the tramway service. With the consent of Mr. Walter Paton and the members of the Tramway Committee, an experimental car, provided with a motor produced and patented by Mr. G Johnston, a Glasgow engineer, has been running during the past few nights over several of the principal lines in the city with a view of testing its efficiency. "So far as we can ascertain," says the *Glasgow Herald*, "the power in use is a combination of steam and electricity (?) but neither smoke nor steam is visible, and the car glides noiselessly along the streets. The motor is contained in a box about 3 feet in height and 2 feet in diameter, and is placed on the front platform of the car immediately behind the driver. The car may be run in either direction, but it is designed to be worked from one end, turning at the close of each journey by means of rails laid in a half circle or triangle." The weight of the experimental car charged for twelve hours' running is 3½ tons, as against the 2¼ tons of the car at present in use. The new motor has been tested on a number of the steepest gradients in the city, such as that in Renfield Street, and it can be started and stopped without difficulty, running lightly or fully loaded. In the event of the adoption of the new motor the existing cars could be adapted for its use without material alteration. The experimental car has not as yet been formally inspected by the Tramway Committee, but it has been favourably regarded by various experts by whom it has been examined, and who have seen it in operation.

Isle of Man Tramways.—The electric railway which is being erected to the summit of Mount Snaefell was to have been opened for traffic last Saturday, but some delay having arisen in the erection of the overhead wires through unfavourable weather, the line will not be available for traffic until to-morrow, 17th inst. To-day Colonel Rich and Major Cardew make their inspection of the line on behalf of the Board of Trade.

Madras Electric Tramways.—A Ceylon paper says that out of about 15 miles proposed to be laid by the company (and for which a concession was granted) only one section of some 2½ to 3 miles has been completed and opened for work. This is working satisfactorily at present; but it is doubted by some if it will do so during the North-East monsoon. "Meantime the original company is, apparently unable to go on with its undertaking, 'and the Construction Company' (with whom it contracted) has taken possession of what has been done, as security for payments due. Further calls on shareholders have been made or attempted; but in some cases resisted on grounds which may become the occasion for cases in court. Indeed, we are told, that an angry feeling has arisen among the Madras, and especially the native, shareholders towards the chief promoters of this ill-fated company. What is to be the outcome of the present deadlock remains to be seen."

Mersey Railway Company and Electricity.—Addressing the shareholders in London last week, the chairman of the Mersey Railway Company said, that after the date of the last half-yearly meeting the directors made a further inquiry into the important matter of working the railway by electricity or other motive power, and decided to proceed with the Company's Bill in Parliament for the necessary powers. The Bill had passed the committee of the first House. Owing to the unfavourable response of the debenture stockholders and the proprietors in regard to raising £50,000 further capital, and to the "scheme," the clauses in the Bill relating thereto were withdrawn. Valuable as the Bill might prove to be, the directors would remind the shareholders and the debenture stockholders of the great necessity for a scheme, either in Chancery or under Act of Parliament, being agreed upon, so that money might be raised when necessary as cheaply as possible. What the new Parliament would do with regard to that Bill he could not say. What the board originally proposed in the Bill had been very materially reduced owing to the refusal of the debenture holders to the scheme of arrangement, and the Act only asked now that the company should be allowed to work the line by electricity.

THE EDINBURGH CORPORATION ELECTRICITY WORKS.

The Edinburgh Corporation Electric Light Works is one of the most recently opened, and, in many respects, is one of the newest of our central stations. It is chiefly remarkable in that it aggregates under one roof two distinct and separate systems of supply. To make the reasons clear that have led to this system, it is necessary to mention two or three geographical facts concerning the district. The town of Edinburgh consists of two districts, which are known as the northern and the southern. The former is compact, and includes the business portion and much of the residential portion of the city; while the southern district is poorer, and the houses and premises, where a supply of electricity is likely to be needed, more scattered. Prof. Kennedy, who has engineered the scheme throughout, in his report to the Town Council, said that the local conditions indicated that a low tension system should be adopted for the northern district, and a high tension for the southern part of the town. This would not be a suitable opportunity to fully discuss this bold departure from previous practice; we can, however, say that the success that has attended the inauguration of the works has been remarkable. It is yet too early to say that this success is due to any peculiarity in the system, inasmuch as the novel part of the design has been intended to meet future demands.

The history of electric lighting in Edinburgh does not begin with the present works; it goes back as far as 1881, when an experiment in street lighting was made under the direction of the Anglo-American Brush Corporation. Princes Street, the North Bridge, and the Waverley Bridge were lighted, but at the end of three months the Corporation regretted their progressive notions, and abandoned the experiment, which had cost over £800. The town had not recovered from those experiments in 1888, when the subject was introduced again to the town authorities. The threatened invasion of the town by joint stock companies in the following year, however, led the Corporation to seek powers for themselves, and they obtained the sanction to a provisional order in 1891.

Edinburgh.—Laying the Mains.

The combined system that has been adopted is a high tension alternating, with Ferranti rectifiers for arc lighting, and a low tension three-wire system.

In the details of the system there are many points of special interest, some of which will be dwelt upon in this article. A most admirable building has been erected in Dewar Place, the architect and builder having wrought most creditably.

The interior of the station, an excellent idea of which will be obtained from our illustrations, is most excellent in its proportions; it is slightly marred in one corner by the want of space, otherwise one could not have desired a finer housing for electrical plant. Vast quantities of concrete have been used in making a flooring; indeed, strength and solidity are plainly evident on all hands, the iron girders which support the roof weighing 12 and 15 tons, while the supporting columns are of similar massive proportions.

Beginning first with the boiler house, one's attention is almost immediately attracted by a room which has been completely set apart for pumping purposes. The pumping arrangements are more than usually interesting on account of their conjunction with electric motors. Indeed, one of the features of the Edinburgh station is the complete use that is made of electricity for mechanical operations, such as pumping, driving mechanical stokers, &c. One of the great advantages of using electric motors for pumping purposes is the flexibility and cleanliness of the arrangement. The pumps at Edinburgh run slowly, not often exceeding 30 revolutions per minute. They can be speeded up to 40 revolutions without much increase in the voltage; with double the voltage, however, a very high rate of speed can be attained. It is the enormous variation in speed that can be effected which constitutes one of the advantages of the electric motor pumps. It is of course desirable, wherever possible, to have one's pumps continuously working rather than intermittently, in order to preserve the steadiness of the steam supply; for irregularity in steam supply means a good deal of work for the man at the switchboard. They are so impressed at Edinburgh with the necessity of keeping the pumps steadily at work, that it is proposed to add a regulating valve, which, while decreasing the efficiency of the pump, is preferable to intermittent running. It might be said that to use electric motors in a boiler house is a very roundabout way of using power, but though the method is perhaps somewhat wasteful, it compares most favourably with steam pumps, and certainly, when employing electricity, one gains by reason of the pumps being kept in excellent condition. The pumps, of which there are two sets, have been made by Messrs. Hayward, Tyler & Co.; they are 15 inches × 8 inches vertical three-throw plunger pumps, plungers of gun metal, with cast-iron glands bushed with gun metal, gun metal valves and seats, steel crank and counter-shaft, spur mortice wheel and machine-cut steel pinion. The pumps running at 30 revolutions deliver 3,000 gallons per hour, or they can be speeded at 45 revolutions to give 4,500 gallons per hour, and all parts are made suitable for working continuously at 160 lbs. on the square inch; they are coupled direct to Siemens motors, the switching arrangements being close at hand.

It is interesting to mention that in the use of motors for various purposes in the station, the Corporation treat themselves as ordinary customers, the supply of electricity for the motors being derived, not from the switchboard direct, but from the street mains; we believe the same principle is followed in the current used for lighting purposes.

In addition to the motor pumps there is in the pump room another motor of about 7 H.P., which is utilised for driving the mechanical stokers. The motor drives on to a pulley, from thence the driving power is transmitted to a horizontal shaft, this in turn driving the stoker shaft.

It may be said that in all the departments of the electrical works there is something which, if not actually novel, embodies the very latest engineering practice; the steam raising plant is no exception to this, for besides being provided with mechanical stokers and moving fire-bars, they have each a superheater.

There are at the present moment six boilers in position, though 17 boilers could be easily accommodated. The boiler house abuts on to the railway sidings of the Caledonian Railway Company. We believe it is the intention to eventually employ an electric hoist for the purpose of conveying the coal to the floor above the boilers. The whole of this floor space, which is considerable, would then be used as a coal store. Shoots would be connected to the hoppers of the boilers, and there would be a direct feed of coal. At the present moment coal is brought into one end of the boiler house and conveyed in small quantities to the boilers, and there shovelled by hand into the hoppers. When, however, the hoppers have been fully replenished, very little labour is needed to keep them supplied; indeed, one man can look

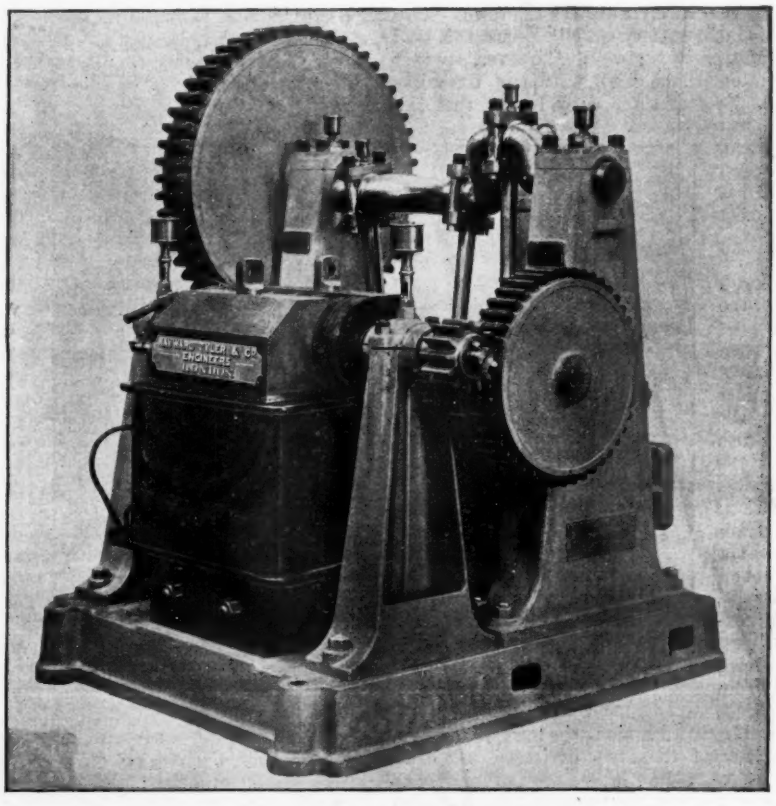
comfortably after three boilers at the same time, and wheel his own coal. No effort has been spared to minimise the labour without sacrificing efficiency, and if Mr. Monkhouse does not show us something very excellent in his wages bill, we shall be surprised.

The boilers are by Mr. George Sinclair, Leith, and are of the Lancashire type. The action of the stokers and movable fire bars has been previously mentioned in the REVIEW. The coal falls gradually on to the fire bars, and by the alternate action of the bars is pushed forward; a clinkering action also goes on periodically. There seems to be always a good thick fire existing, even without attention from the stoker, but if it were necessary, the fires could be slightly forced by hand. The action of the bars is so complete, that the residuum from the fire is absolutely useless. The coal that is used is of first-rate quality, and, in spite of its lowness in price—7s. per ton—is of high calorific value.

In mentioning the superheaters, it is hardly necessary to point out the marked economy that may be effected in some stations by the use of superheating. We may take it that, under ordinary circumstances, we shall lose several pounds of steam in getting from the boilers to the engines; but this waste can be most effectually minimised by a good system of superheating. As a matter of fact, in Edinburgh, while the boiler pressure may be 150 lbs., the ganges in the engine room will be standing at 148; the total loss, notwithstanding the long steam piping, rarely exceeding 2 lbs. How important this saving would be in a twelvemonth, we need hardly dwell upon here. The superheater, which, for want of a better name, we will call the Sinclair superheater, consists, practically, of a huge coil of pipes fixed immediately over the boiler. The whole of the steam, before passing into the ring main, passes through the superheater; should anything go wrong with any of the superheaters, however, the steam, by a suitable arrangement of valves, can be made to pass direct from the boilers into the steam main. There is in the boiler house a MacDougall steam trap, for the purpose of draining the main steam pipe; in addition, there is a Berryman feed-water heater. From some rough tests made on this heater at the Edinburgh Station, it was found that the temperature of the water passing from the feed-water heater into the boiler was 209° F., a highly satisfactory state of things.

The boiler house, or that portion of it in which boilers are erected, is lighted by means of two 10-ampère arc lamps, while the remainder of the boiler house, which is for the present used as a coal store, is lighted by incandescent lamps, the pump room is lighted in a similar way. The strictest economy appears to be exercised with the station lights, the men appreciate the fact, and are distinctly careful. We mention such small things as this, because it is our opinion, as expressed in a former issue, that it is in the small details of central station working where one can effect marked economy. It is worthy of mention that though the boiler house, as well as the rest of the station, is not yet out of the contractor's hands, it presents a very neat and tidy appearance.

Naturally the most prominent features in the Edinburgh system are in the generating room; as we have already said,



EDINBURGH.—ELECTRIC MOTOR PUMPS.

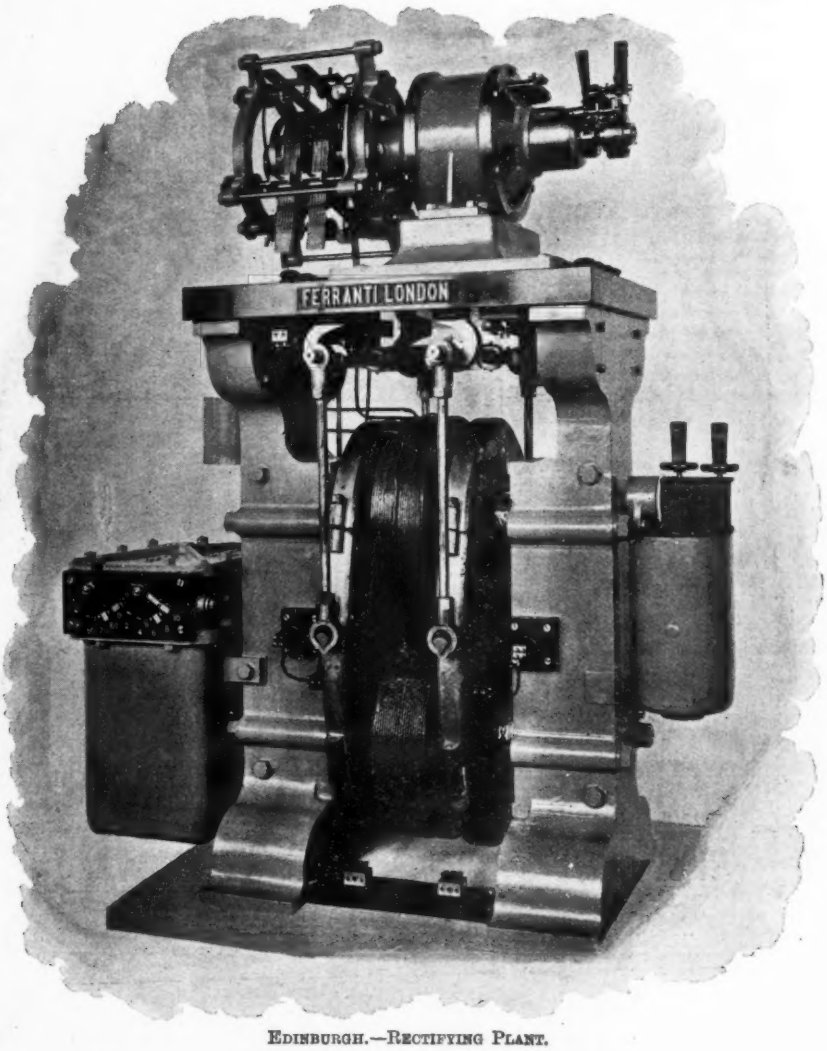
its most conspicuous novelty consists in the aggregating together of two systems.

Sunderland may claim to be the first town to actually put down such combined plant, under the advice of Prof. Kennedy, but it is on a much more moderate scale than obtains at Edinburgh.

Although the two systems are under one control, and are in common so far as steam raising plant is concerned, they are in all other respects quite distinct. It seems to be the intention to preserve one side of the station entirely for the low pressure system and the other for the high pressure machines. Each system has its separate switchboard, but they are within easy distance of each other, though that is not a matter of importance, seeing that each switchboard will have its own special attendants.

Dealing, first, with the low tension side, we would remark that the plant does not materially differ from that in use in many other low tension systems. The dynamos are of the Siemens type, two-pole drum armature machines, which are direct coupled on combination bases to Willans engines. There are four large machines coupled to 111 S compound

engines, which run at 350 revs., give 360 I.H.P.; there are two of more moderate size coupled to two II S compound engines, which run at 350 revs. and indicate 240 I.H.P., and four small machines coupled to G.G.S. compound engines of 100 H.P. each. The larger machines were doing excellent duty on the occasion of our visit, there being not the slightest sparking. A noticeable feature in the arrangement of these machines is the space that has been provided, there being ample room all round the machine; indeed, there would be no difficulty in taking any of the machines to pieces without having to move the parts. We shall best describe the other portions of the low tension system as almost the exact counterpart of the ones at Belfast and at Sunderland. Accumulators are used at Edinburgh in conjunction with the dynamos in pretty much the same fashion as they are employed at Belfast.



Edinburgh.—Rectifying Plant.

There is the automatic means of cutting out the cells from the dynamo circuit, and there is the capitally-designed switch for varying the number of cells put on to the lighting circuits. The accumulators are situated in a room above the engine room. Besides the battery for ordinary work, there are the "hospital" cells, which may act as a reserve, or they can be utilised to raise the voltage at the end of a feeder. The switchboard, again, is very much like the one we described at Belfast; in the case of Edinburgh, however, the contractors have been Messrs. Siemens Bros., Limited, and it must be said that they have provided a very excellent specimen of switchboard work. There are the machine panels and feeder panels, and the usual measuring instruments. A Holden hot-wire instrument is being tried, and appears to be giving much satisfaction. The switchboards are raised on a wooden platform about 4 feet 6 inches from the level of the engine room floor. Before passing on to speak of the high pressure system, it will be as well to follow the low tension system into the streets.

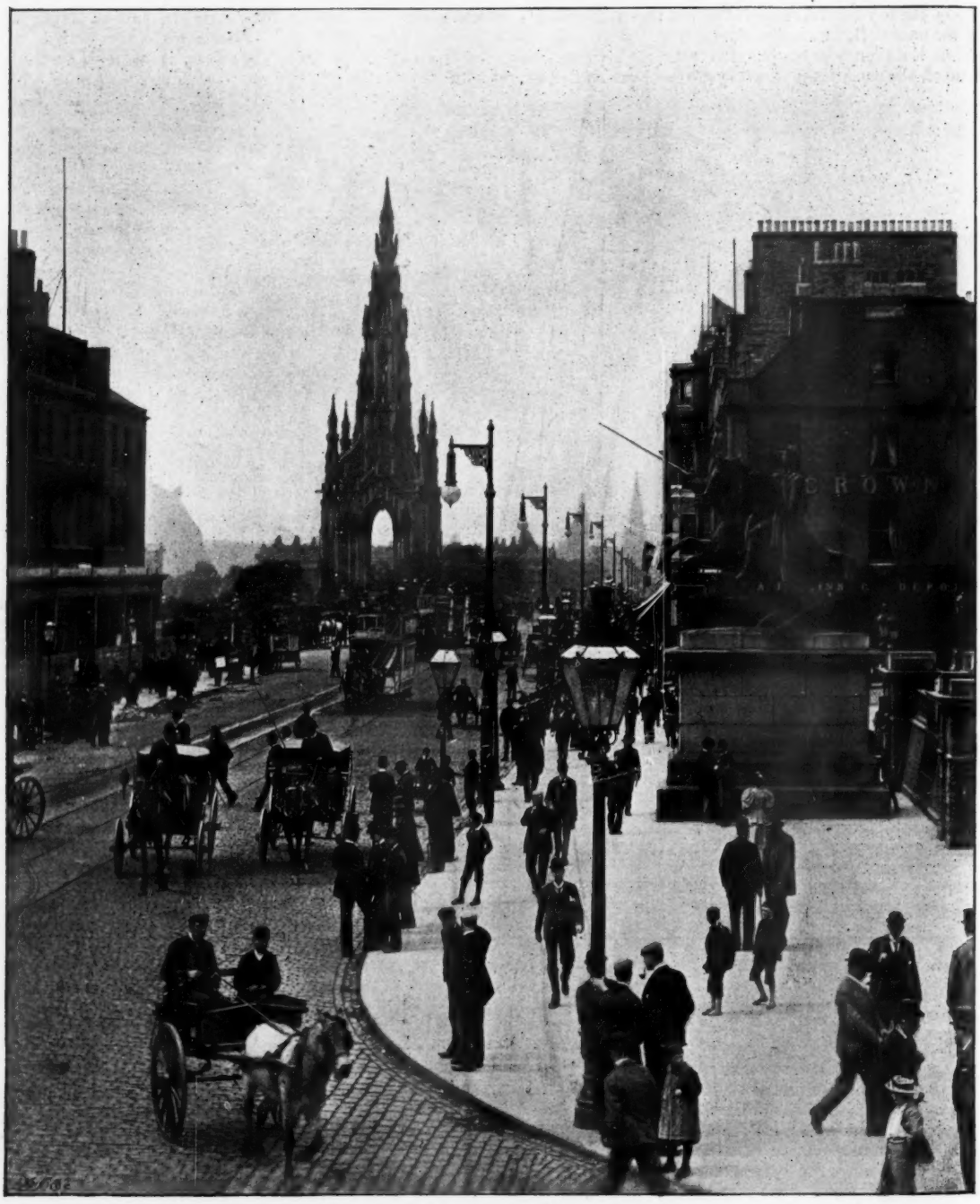
After leaving the switchboard, the mains are taken to a cellar which has been specially designed to accommodate them, from whence they radiate to different portions of the town, each set of mains being labelled with the name of the district which it traverses. The pipes which carry the mains to the cellars are painted in distinctive colours, red, blue, and white, the latter being the middle wire. In this cellar one obtains glimpses of the ends of the Doulton conduits, which carry the cables. While on the subject of the street mains, a description of this system will not be amiss.

The material of which the casing is made is hard-burnt glazed stoneware; it is a non-conductor, and proof against chemical action due to acids and gas found in the soil. While the cheapness and durability of stoneware has led to its almost universal use underground for drainage purposes, until a few years ago it had been adopted to a very limited extent for electrical conduits, and no successful attempt had been made to design a satisfactory electrical subway in this material, until Messrs. Doulton introduced their casing. The underground work at Edinburgh is a distinctly successful example of the use of stoneware casing, as upwards of 70 miles of "ways" have already been laid, and extensions are in progress. The whole has been laid by the Corporation's own men, under the direction of their engineer, Mr. Monkhouse. The casing was supplied in lengths of 3 feet, provided with two, three, or four "ways," each 2½ inches square.

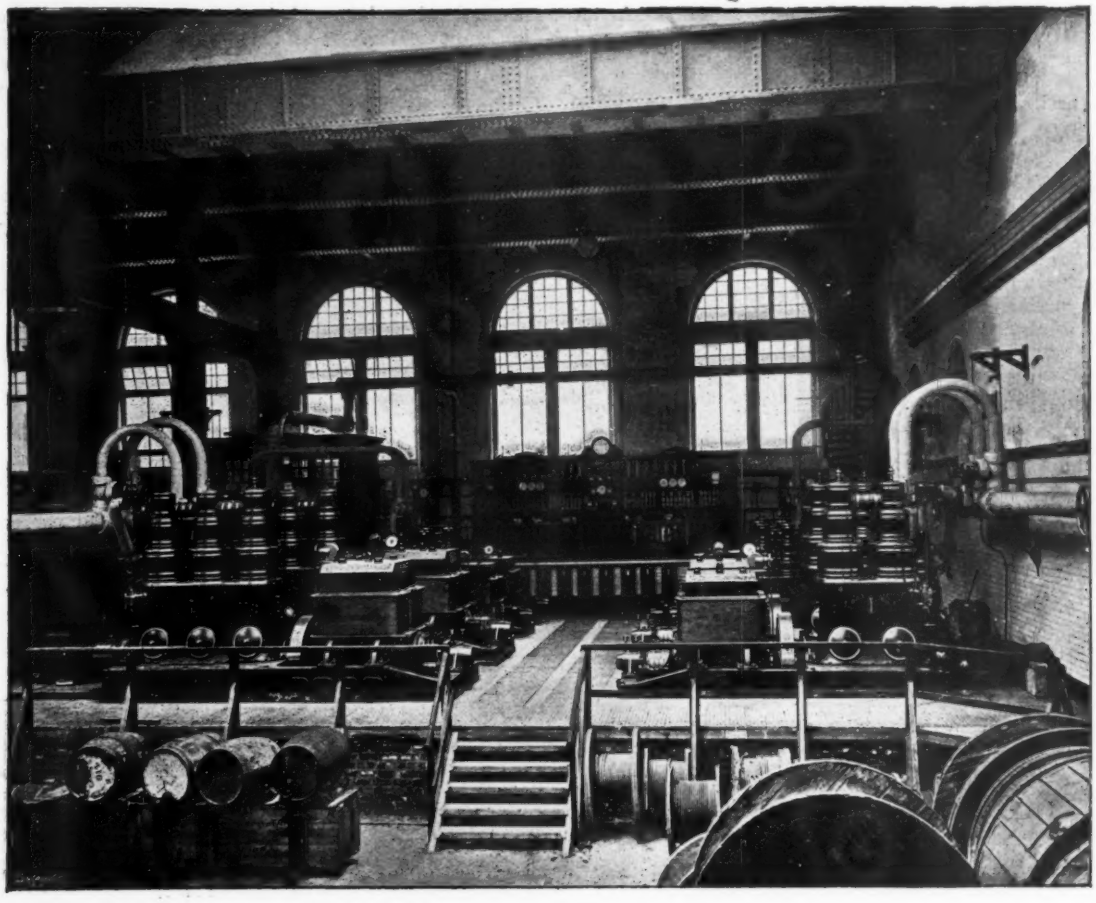
The method of jointing the lengths is shown in the

accompanying illustrations. They are laid, with a small space between them, on shallow cast-iron bearers (figs. 1 and 2). A mandril with India-rubber head is then introduced into each of the ducts (figs. 3 and 4), and when opposite the joint between the lengths is expanded by a few turns of a fly-nut at its end. A removable iron mould (fig. 5), open at the top, is placed over the joint, and is simply filled with a special rapidly-setting bituminous cement. This hardens in two or three minutes, and the mandrils are unscrewed and withdrawn, and the iron cover removed (fig. 6). The cement entirely encloses the ends of the lengths, and fills up the space between them, except where occupied by the mandrils. An important feature in connection with the mandrils is that they accurately centre the ducts in each length one with another, and maintain each "way" entirely separate and continuous, with a smooth uniform section throughout the total length of the conduit.

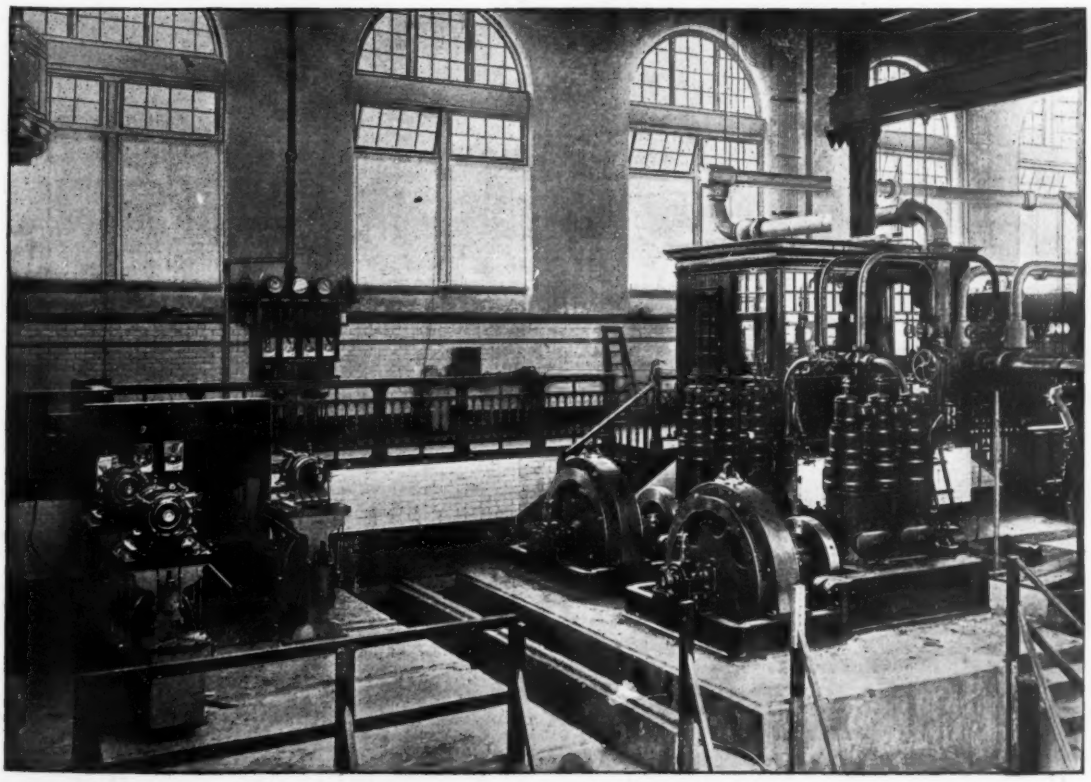
Provision for house connections has been made by means of an inexpensive form of box, designed by Prof. Kennedy. The box consists of a short length of casing (with two, three, or four "ways"), the substance of which during manufacture is partially divided longitudinally in such a way that the upper and lower portion may be separated when required (figs. 7 and 8). The box is laid in the same way as an ordinary length of casing. When it is required to make a house connection, both halves may be removed from the line of conduit, and ample access to the cables is thus afforded. The cable connections having been made, the box is replaced, and in making the joints with the adjacent lengths of casing, a special cast-iron collar is used, provided with an outlet through which the branch cables are conveyed. Should a T-connection have to be made at a point where no box has been provided, there is no difficulty in cutting out a portion of conduit where required, without injury to the cables previously drawn in,



Edinburgh.—Arc Lights in Princes Street.



Edinburgh.—Low Tension Side.



Edinburgh.—High Tension Side.

and substituting a service-box of stoneware or of brick. A portion of the mains consists of bare copper strip, supported on stoneware insulators of Doulton's manufacture, built in concrete culverts.

Returning now to the central station for the purpose of considering the high pressure system, we would remark that its chief characteristics are the use of commutated currents for arc lighting. There is nothing being done in the way of private lighting from the alternating current side, but there is every indication that it will be soon necessary to proceed with it. We are becoming somewhat used to rectifying plant, but though the novelty of their introduction has somewhat worn off, the rectifiers in use at Edinburgh are worth considering, because they exhibit some important departures in construction from those at Portsmouth and Cardiff.

There are three Ferranti rectifiers, each capable of supplying 40 lamps in series. The rectifier consists of a combined synchronous motor and double break commutator, mounted on a slate table. One of the most conspicuous alterations is that the commutating arrangement, which in the case of Portsmouth were at both ends of the spindle which projected from the synchronous motor, is now placed at one end. Another distinct improvement which has been effected is the base of the apparatus is occupied by the constant current transformer, which maintains the current at 12 ampères throughout its whole range, viz., from 1 to 40 lamps. The movable coils of this transformer are supported on knife-edges, thus reducing the friction to a minimum.

In order to prevent a sudden load coming on the alternators in switching on the lamps, a water resistance switch is mounted on the right hand side, and the lamp circuit is slowly closed through it, thus giving the engine time to take up the load.

Current for the synchronous motor is supplied by the variable voltage transformer on the left, and is rectified for the fields of the motor by a separate small commutator. The whole arrangement, it will be seen, is very compact, and occupies very little floor space. The whole of the improvements that have been made in the apparatus are clearly shown in the illustration. It will be seen from other illustrations that the rectifying plant occupies a position on the floor of the engine room, such an arrangement conducing, perhaps, to better control.

What is of interest is the type of alternator, which has been supplied by Messrs. Ferranti. These machines appear to possess exceptional mechanical strength, and though we had not the pleasure of seeing them running, we have reason to believe that their performance is very good. These alternators are two in number, and have each an output of 84 kilowatts, viz., 40 ampères at 2,100 volts. They are coupled by means of a rigid coupling to a Willans engine running at 450 revolutions per minute, and the periodicity is the same as the Portsmouth machines, viz., 50 ~.

The armature is stationary, and the winding is of stranded copper wound through tunnels in blocks, consisting of charcoal iron stampings, solidly baked together, and held in heavy cast-iron ring frames. The ends of the coils are protected by brass boxes on each side of the ring frames, which give very great security, and also an excellent finish to the plant.

The rotating field magnet consists of two heavy steel crowns, with laminated faces on the pole projections. These two crowns enclose the field magnet coil, which is excited from the direct current bus bars at a voltage of 250. The exciting current is carried to the revolving field magnets by two phosphor bronze rings, one on each side. The shaft runs in spherical bearings, lined with white metal, which, in turn, are carried by heavy pedestals.

The bedplate is of girder section, and carries the pedestals and armature frame. It is strongly bolted to the engine bed, forming with it a rigid, continuous base for the combined plant.

The switch gear for the alternating current machinery is of the well-known Ferranti type, and provides for two alternators and two circuits, with capacity for extension.

The frame consists of enamelled slate slabs built into the

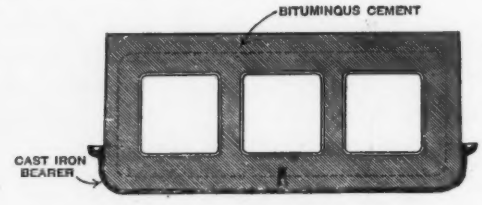


Fig. 1.—Cross Section at Joint.

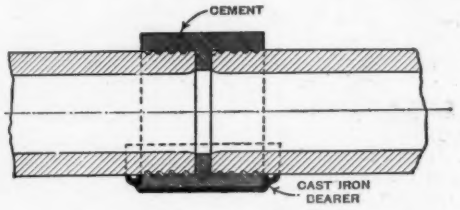
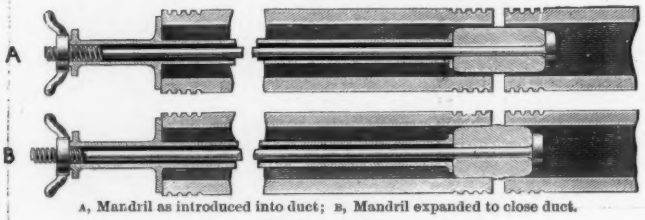


Fig. 2.—Longitudinal Section.



A, Mandril as introduced into duct; B, Mandril expanded to close duct.

Figs. 3 and 4.

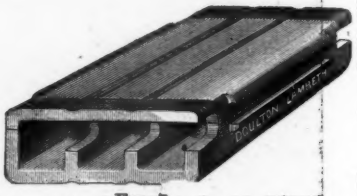


Fig. 7.

Fig. 5.—Mould in Position for Jointing.

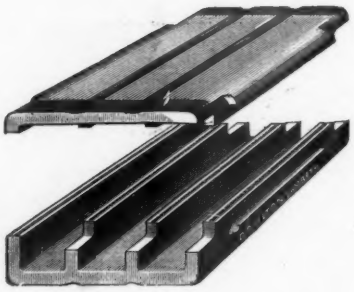


Fig. 8.

Fig. 6.—Joint Completed.

Doulton Conduits.

wall of the engine room. The alternator and circuit cables enter from below through concentric gun metal glands. The outer, or earthed poles, are connected by removable links on the lower slate. The high tension, or inner poles, pass upwards to the oil-break fuses. These fuses are so arranged that they can be cut out by a plug, and removed for renewal or inspection without opening the circuit. Above the fuses are the Kelvin ampère gauges.

The bus bar on the top of the gear is double, and any alternator or circuit can be connected to either section, two switches being provided for this purpose between the bus bars and the alternators and circuits. This allows of the alternators being run on separate circuits or in parallel.

High tension Kelvin electrostatic voltmeters of the multicellular type, with very open scale, are mounted on the top slate.

The exciter rheostats and ammeters are arranged below the switch gear, with a hand wheel and screw to move the sliding contact over the stops. The wall space occupied is 5 feet wide by 7 feet 6 inches high. All parts carrying high tension current are amply protected.

The arc light distribution switch gear comprises a panel with ammeter reversing switch, and polarity indicator for each rectifier. By an arrangement of plugs and flexible leads, any rectifier may be connected to any circuit. The instruments on this gear are of Nalder Bros. & Co.'s manufacture.

The mains from the switchboard are taken to a cellar much in the same way as in the case of the low pressure, from whence they radiate to different parts of the town.

The street lighting is of especial interest; indeed, the lighting of Princes Street may be reckoned one of the glories of Edinburgh. The line of light from one end to the other shows scarcely any variation, save towards Calton Hill, where there is a slight rise in the road; apart from that, it is an unvarying line, and is about as good a piece of work as we have seen. Although Princes Street is straight, as streets go, there is really considerable deviation from the direct line, and the labour of placing the lamp in such a way as to compensate for this must have been considerable. At midnight half the lamps are turned out, but the remaining light is more than ample for the belated pedestrian, if such do exist in Edinburgh. There are several other streets that are lighted, the total number of lamps at the present moment being about 150. George Street and George Square are to be shortly added to those that are electrically lighted, and, eventually, Edinburgh will acquire the reputation of being one of the best lighted towns in the country. Crompton lamps of 15 ampères and 10 ampères are used, and give excellent results. The turning off the lamps at night is done by hand, a man being despatched on a bicycle for this purpose. It is worth mentioning that the saving of current that has been effected since a man was sent round on a bicycle, instead of on foot, is upwards of £40 per annum. The time previously taken was $1\frac{3}{4}$ hours, but it takes now about half-an-hour.

We need hardly dwell upon the future of the Edinburgh Electric Lighting Works, when it is mentioned that over 20,000 lamps are now connected, and these are exclusive of arc lamps; there is sufficient reason to believe that it will be a remarkable success.

We are very much indebted to Mr. E. W. Monkhouse, the corporation engineer, for the assistance he has given us in preparing this article.

The pictorial illustrations have been reproduced from photographs by Mr. Alex. A. Inglis, of Calton Hill, Edinburgh.

SUNDERLAND ELECTRICITY WORKS.

Prof. Kennedy has been responsible for the design and erection of the Sunderland electricity works, and, as we have already mentioned, the system is in many respects similar to Edinburgh. Apart from the question of size the chief point of difference is that the alternators are driven by continuous current motors.

Sunderland has passed through various phases in electric lighting; a company made a bold show in 1883 by obtaining a provisional order, but this was revoked two years later. Then the Corporation tried to do some hard bargaining with electric supply companies, but, failing, they undertook a project of lighting the town themselves.

The works are situate in a central position of the low-tension area, which comprises mostly the business portion of the town. As a matter of fact the high-tension side of the works has not yet been much developed. The alternating current plant is in position, but nothing has been done with regard to laying the mains.

The low-tention plant consists of two sets of Willans E.E. engines coupled direct to Holmes & Co.'s dynamos, which give each 170 ampères at 135 volts; three larger sets, Willans G.G. engines, are connected to similar dynamos having an output of 210 ampères at 240 volts. The larger machines are naturally for feeding on the two outside wires of the system, balancing being done either by the small machines or by the accumulators. The switchboard is similar to the board at Edinburgh, and is identical with the one at Belfast, being in fact made by the same firm, Messrs. H. B. Holmes & Co. The accumulators play the same part in the working of the system as at Edinburgh, and on those grounds it is unneccessary to repeat them. The battery room is roomy and convenient, and is furnished with a set of E.P.S. accumulators giving 500 ampère-hours capacity.

Coming to the other side of the system there are two motor alternators, each designed for an output of $37\frac{1}{2}$ kilowatts at 2,500 volts (alternating) at 550 revolutions, the input being about 190 ampères at 200 to 220 volts (continuous). The alternators are of Messrs. Crompton & Co.'s usual type, and have 12 poles. The brush gear is in duplicate, and so designed and insulated that a brush may be removed from either collector ring without interrupting the supply. The collector rings are mounted one on each side of the armature.

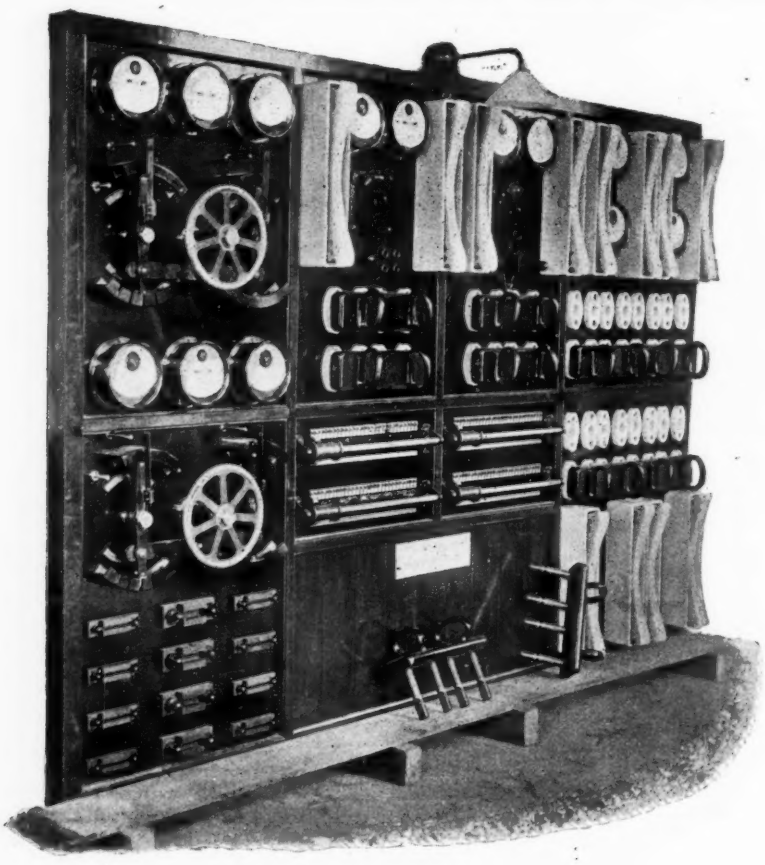
The continuous current motors are of the usual pattern, with single magnetic circuit fields, shunt wound, and drum wound armatures. Each machine has three bearings with brasses of phosphor bronze and automatic lubrication by means of rings. After construction and before leaving for Sunderland both machines were put through an exhaustive series of tests. First, each machine underwent the usual six hours' full load run. Secondly, they were run in parallel at different loads from nothing up to the full amount. Experiments in transferring the loads from one machine to the other were also made. Finally the true efficiency of the complete plant was measured, from which the following figures were obtained:—

At full output	(15 ampères)	$84\frac{1}{2}$	per cent.
At half „	($7\frac{1}{2}$ „	) 81	„

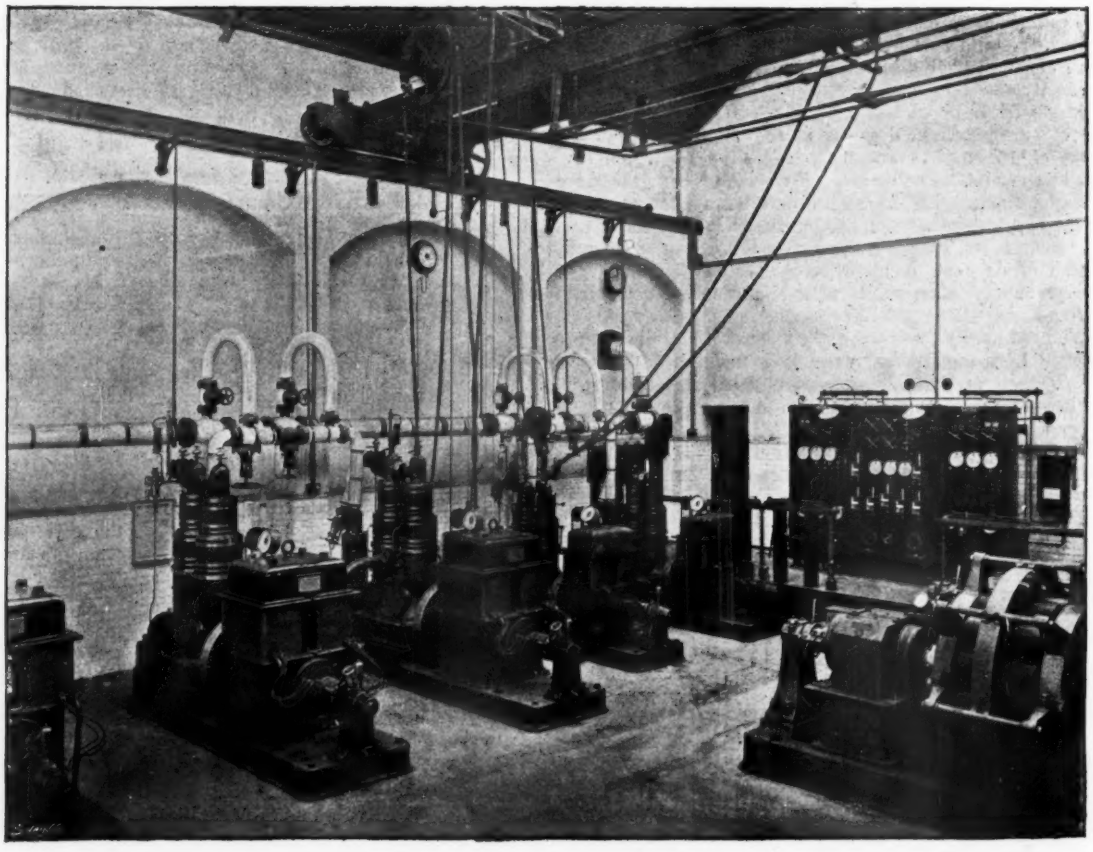
The tests were made by coupling the two alternators together so that one drove the other as a motor. Continuous current was put into one of the motors and the other motor was loaded up as a dynamo. During the whole of these experiments the parallel running was remarkably perfect and steady.

The switchboard, which is illustrated, consists of the usual varnished teak frame with enamelled slate panels. On the first two panels on the left-hand side are arranged all the switches and instruments for starting and controlling the two continuous current motors. Each motor is started by means of a double pole starting switch and resistance which at the same time connects the shunt winding in the proper manner and also the field winding of the corresponding alternator. To each machine three instruments are provided, one of which measures the exciting current round the motor field magnets, the other the exciting current round the alternator field magnets, and the third the motor armature current. At the bottom of the panel double pole fuses are provided for these three circuits for each machine.

The next two panels are occupied by the switches, fuses, and instruments belonging to the two armature circuits of the two alternators, including the plug switches for connecting the alternators to the synchroniser, so that they may be put into parallel. Two voltmeter switches are fitted on these panels, by one of which the E.M.F. of either alternator may be read, and by the other the volts on either bus bar. There are two main switches to each alternator, because two bus bars are provided and it is necessary to be able to use



SUNDERLAND.—SWITCHBOARD.



SUNDERLAND.—VIEW OF DYNAMOS.

either alternator on either bus bar or on both. Below these two panels are two similar panels, containing the regulating switches for the field magnet circuits of the alternators and motors. The last two panels, arranged one above the other, are occupied by the circuit fuses, switches and instruments, and on them provision is made for four circuits, any one of which can be worked from either bus bar.

All the measuring instruments are of Messrs. Crompton and Co.'s manufacture, the high tension voltmeters being of the electrostatic type. The high tension fuses and switches are mounted entirely in stoneware, and the latter are of the plug type with renewable contacts. Beyond this the Corporation have not proceeded with the alternating scheme, but it is desirable that the Corporation should make proper use of the plant, and, no doubt, under the guidance of Mr. C. S. Vesey-Brown, the borough electrical engineer, they will shortly lay the necessary mains for supplying current outside the low tension area. The cables are drawn into Doulton casing, with 2, 3 and 4 ways, each 2¼ inches square, and the bare copper mains are supported on insulators supplied by Doulton and Co., and built in concrete culverts.

The load on the station at the present moment is not very considerable, but then the period at which the works were started was not a very good one for securing customers, it being in March of this year. There is no doubt, however, that with the commencement of the winter season there will be many accessions to the number of customers.

Mr. C. S. Vesey-Brown has superintended the whole of the erection of the plant and the laying of the mains.

NOTES.

Mr. Livesey and the Electric Light.—At the half-yearly meeting of the South Metropolitan Gas Company, held at the Bridge House Hotel on Wednesday afternoon, Mr. George Livesey, the chairman, specially alluded to the article in the ELECTRICAL REVIEW last week on "Payment on a Piece Rate System." He said that as chairman of that company he had never before said one word about the electric light so far as their company was concerned. The electric light had gained no footing in their district. They had shown them no antagonism—in fact, the company's people had given the electric light companies every facility for laying their mains. Now, however, they seemed to be getting a little bit spiteful, judging from what he read in the ELECTRICAL REVIEW: "We wonder if gas companies do this? Their consumers' meters always seem to run very fast as though trying to outrun the work's meter. . . . . The system of profit sharing is very usually condemned by those who advocate piece work, yet it appears to have its field. If we are to judge from the accounts in the daily papers, the South Metropolitan Gas Company seem to be getting along with their men very well on the line of profit sharing. The workers seem to have accumulated some £60,000 during six years as the result of the scheme. A gas works, however, which starts the system, has the advantage that it need never stop it. They have such opportunities of squeezing another ten or fifty thousand out of the public by increased charges, or of saving at the works by reduced cleansing of the gas, or a reduction of lighting power, that the great bane of profit sharing, viz., a year with a loss, never occurs." Mr. Livesey said that what he had read amused and rather pleased him, because when persons began to get spiteful, it was tolerably clear proof that they were losing.

Personal.—Mr. R. C. Holness, who has been one of the engineers in charge of the generating station of the City and South London Electric Railway since its opening, has been appointed assistant electrical engineer on the electric tramways in Madras, and commenced work there on July 6th.

Mining Institute of Scotland.—A meeting of this institute was held in the Hall of the Royal Scottish Society of Arts, George Street, Edinburgh, on Saturday last, when Mr. Mitchell read a paper on "Electric Coal-Cutting at Glencleland Colliery," which elicited an interesting discussion.

Horseless Carriage Contest.—A London daily says that a horseless carriage race between Chicago and Milwaukee, promoted by the *Times Herald*, of Chicago, will be decided on Saturday, November 2nd, the object being to encourage and stimulate the invention, development, perfection, and general adoption of motor carriages. The amount offered in prizes is $5,000, apportioned as follows:—First prize, $2,000 and a gold medal, open to competition to the world. Second prize, $1,500, with a stipulation that, in the event the first prize is awarded to a vehicle of foreign invention or manufacture, this prize shall go to the most successful American competitor. Third prize, $1,000. Fourth prize, $500. The third and fourth prizes are open to all competitors, foreign and American. The rules laid down stipulate, among other things, that no vehicle shall be admitted to competition which depends in any way upon muscular exertion, except for purposes of guidance. Competing vehicles which derive their power from petroleum, gasoline, electricity, or steam, and which are provided with receptacles for storing or holding the same, will be permitted to replenish the same at Waukegan, Ill., and at Kenosha, Wis., but at no other points.

Storage Batteries at Niagara.—In the last issue to hand of the New York *Electrical Engineer*, there is a leading article in which is discussed a question relating to the more economical utilisation of the Niagara power. The flow of water of course continues throughout the entire 24 hours, whereas operations are, we understand, carried on only during 10 hours of the day, thus utilising less than one-half of the power available with a corresponding non-utilisation of the entire hydraulic and electric plant. As few, if any, of the industries using power from Niagara will be operated 24 hours per day, our contemporary thinks it should be considered whether some method of storing the energy during the night at the power station or at the factories may not prove economical, and looks upon electrical storage, and that alone, to fulfil the requirements. Our contemporary's belief in the adaptability of the storage battery for Niagara is strengthened by the character of the enterprises already established there, and that of others which will follow, and which require the continuous current as an absolute necessity. The question is a purely financial one, and involves the consideration on the one hand of the cost of wheel pits, turbines, generators, static and rotary transformers, and, on the other hand, the rotary transformers and storage batteries of a capacity sufficient to store the energy of the machines required for the day load. The addition of a storage battery at Niagara, either at the main power house or at the points where the continuous current is required, would thus fulfil the necessity of affording a proper utilisation of available energy, and provide two sources and two kinds of current adapted to all purposes for which current can be utilised.

Electric Lighting of Buoys.—An illustrated article appears in the *Electrical Engineer* of New York for July 31st, on the lighting of buoys in New York Harbour, from which we learn that the original system established early in 1892 has recently been extended, and there are now 10 buoys lighted by electricity. Those on the South-West Spit circuit are supplied with direct current at 150 volts, while the Gedney Channel circuit is on the alternating system, the primary voltage being 1,000, which is reduced to 100 volts at each buoy by a transformer. The total length of cable used to connect the buoys with the generating station at Sandy Hook is 6·18 miles. This cable is throughout insulated with gutta-percha. A novel feature is the use of hard drawn copper wires, each 0·0403 inch in diameter, as a sheathing to the cable carrying the alternating current. The success of the system seems to be largely due to the use of spar buoys. We fully described these buoys in our issue of April 1st, 1892, and further reference to them in connection with lightships appeared on April 29th and June 3rd of the same year.

Refuse Destructors.—Before the British Institute of Public Health Congress, held at Hull last week, Mr. E. Manville, M.I.E.E., read a paper on "Refuse Destructors as Applied to Electric Lighting Purposes."

The Conductivity of Metals and Electrolytes.—There is an interesting theoretical investigation recorded in a recent issue of the *Annalen der Physik und Chemie* regarding the views which are held respecting the mechanism of the process of electrical conductivity in electrolytes, and in metallic conductors respectively. It is generally accepted that when a current passes through an electrolyte, deflects a magnet, and heats the conductor, it does so conforming to the same laws as those which govern the behaviour where metallic conductors are concerned. But although this view is generally held by physicists, they are at variance in describing the mechanism or *modus operandi* of the process in the two cases. Thus in a metallic conductor the electrical disturbance is regarded as taking place in the surrounding ether, a molecular, non-electrical disturbance occurring in the conductor itself, whilst, on the other hand, in an electrolyte the electrical energy is regarded as being transported by the smallest particles of the mass (the ions), the ether not being in any way concerned in the change. This variance of views, regarded from a bare philosophical standpoint, strikes one as distinctly weak on the face of it. Karl Streker, in his paper (which our readers may consult in the *Annalen*, 1895 [2], liv., pp. 434—441), goes farther, and claims that these modes of regarding the same phenomena in the two different cases are actually contradictory. In the case of an electrolyte, he suggests that the ether is still the seat of the electrical discharge, the mechanism of the conductivity being the same, practically speaking, as that which obtains in the case of a metallic conductor. His theory is that the ions transform electrical energy into kinetic energy, which, on the liberation of the ions at the electrodes, becomes chemical energy. It is to be hoped that ere long there will be some experimental confirmation or refutation of this theory.

Action of the Electric Current on Sulphides.—We had occasion some months ago to call attention to some experiments which were being made by Jules Garnier, with a view to studying the action of the electric current on fused metallic sulphides. He has now published some new results in a paper recently contributed to the *Proceedings* of the Paris Academy of Science (*vide Comptes Rendus*, 1895, cxx., pp. 184, 185). Crude nickel sulphide was fused into an earthenware tube provided with carbon electrodes; this was then subjected to the action of a current of 10 volts and 23 ampères. It was observed that the conductivity remained very regular, although the voltage gradually diminished; and this happened whilst the temperature of the furnace was maintained practically constant. The sulphide altered in composition during the experiment, and at the close its composition was ascertained to be as follows:—Anode product = 16·60 per cent. S, 35·40 per cent. Fe, 5·13 per cent. Ni, 39·90 per cent. Cu; cathode product = 4·70 per cent. S, 49·10 per cent. Fe, 19·10 per cent. Ni, 26·13 per cent. Cu. The composition of the original product was 21·10 per cent. S, 33·30 per cent. Fe, 16·30 per cent. Ni, and 29·00 per cent. Cu. Hence it appears that the action of the electric current upon the given sulphide was to eliminate to a large extent the sulphur (probably in the form of carbon bisulphide), and to concentrate the remainder at the anode; whilst the nickel was increased from the anode to the cathode, the copper in the reverse direction, and the iron was slightly increased at the cathode. It is possible that when Garnier has completed these experiments on the metallic sulphides, he may be in a position to evolve some new and good process for treating the ores of the metals, especially those which are found as sulphides, by means of the electric current.

Crystal Palace School of Practical Engineering.—The ceremony of presenting the certificates awarded at the close of the summer session to the students of the Crystal Palace Company's School of Practical Engineering took place on Friday last in the lecture theatre of the school. Certificates were awarded to students in the drawing office, pattern shop, and fitting shop, and also in the civil engineering, electrical, and colonial sections.

The Lighting of Westminster Abbey.—Experiments are at present being conducted at Westminster Abbey to decide the suitability, or otherwise, of electric lighting. The organ loft, which is at present lighted by gas, and always a more or less dreary corner, is to be tried first.

Last Saturday's Storm.—The lightning which accompanied last Saturday evening's unusually severe storm, was responsible for serious damage to property in various parts. We hear that at Douglas, Isle of Man, an hotel was struck by lightning, which passed from a flagstaff carrying an electric arc lamp through the hotel, destroying all the electric fittings. The ceiling of the billiard-room was set on fire, but the flames were soon extinguished.

Electric Tanning in Sweden.—We learn that a company has just been formed in Stockholm, to be known as Wenersborg's Leather Industry Company, to acquire and exploit the Swedish-Norwegian patents of the Groth electric tanning process. The company has acquired one of the leading tanneries in Sweden, where the process is to be practically applied.

Sir W. F. Cooke's Private Letters.—We understand that Her Majesty the Queen has been graciously pleased to accept a copy of "Extracts from the Private Letters of the late Sir W. F. Cooke, relating to the Invention and Development of the Electric Telegraph," which work was recently published by permission of the Institution of Electrical Engineers.

Coast Communication.—The members of the Royal Commission on Electrical communication to Lighthouses and Lightships started on a tour of inspection to Denmark and the Baltic on Tuesday, 13th inst. All the principal Danish lightships and lighthouses, both in the Baltic and North Seas, will be visited. The Post Office authorities have placed their cableship *The Monarch* at the disposal of the Commission for this tour. The Commission expect to return to England about Friday, 23rd inst.

The Institution of Junior Engineers.—The annual summer meeting of this Institution, whose headquarters are in London, takes place from August 17th to 24th, the rendezvous being Belgium. The towns to be visited include Antwerp, where the municipal docks, M. Kryn's diamond-cutting works, and other places of interest, will be opened to members' inspection. At Ghent, MM. Carelo's Engine Works, M. de Hemptinne's Cotton Spinning Works, and M. Van Houtte's Nursery Gardens will be seen; at Brussels, the Electric Lighting Station; whilst at Liège the Works of the Société Cockerill, the Vieille Montagne Zinc Works, the St. Leonard Locomotive Works, the Val St. Lambert Glass Works, the Small Arms Factory, and the Electric Tramway Installation will be visited. In honour of the Institution, a banquet is to be given by the Liège Section of the Society of Engineers from the University, and the members will also be the guests of the Société Cockerill. An excursion to Verviers, where the Chamber of Commerce will entertain the visitors, is arranged for the purpose of seeing works in connection with the woollen cloth industry. Here MM. Peltzer's works, and those of M. Duesberg-Delrez, La Vesdre, and M. Hauzeur Gerard fils, will be opened. The celebrated Gileppe reservoir, from which Verviers receives its domestic and manufacturing supply, is also included in the programme. A large number of members have notified their intention of being present at the meeting, which promises to be one of the most successful the Institution has held.

TELEGRAPH AND TELEPHONE NOTES.

A New Submarine Cable.—The contract for the supplying and laying of a telegraph cable between Obock and Djibouti for the French Government has been secured by the Société Industrielle des Telephones, of Paris, for the sum of £13,600.

Interruptions to Cables and Landlines.—Cable, Brest—St. Pierre, Anglo-American Company, April 6th, 1893. Cable, Accra—Kotonou, August 12th, 1895. Cable, Accra—Lagos, August 12th, 1895. Landline, Saigon—Bangkok, August 12th, 1895.

Telephonic Communication with Constantinople.—It is reported that negotiations are at present in hand with reference to the establishment of telephonic communication between Budapest and Constantinople. The establishment of a line between Budapest and Belgrade is shortly to be commenced. The Servian Government has already agreed to the scheme, and it now only rests with the Turkish authorities as to whether the line shall be continued to Constantinople.

Telephone Grievances.—The Halifax Chamber of Commerce were the other day asked to assist the Dewsbury Chamber of Commerce in bringing certain grievances before the company's notice.

The Pacific Cable.—A despatch, dated August 9th, from Victoria (British Columbia), says that it is stated there that Mr. F. W. Mackay, the Canadian Pacific Railway, and a number of San Francisco capitalists are co-operating with a view to securing the contract for laying the projected Pacific cable.

The Telegraph Wire Export Trade.—Still another exceedingly quiet month has to be chronicled as regards the export trade of this country in telegraph wire and apparatus connected therewith, the exports during July only having reached a total value of £82,421 as compared with £99,572 in the preceding month and £303,483 in July, 1894. The great diminution in trade this year is well shown by the figures for the first seven months of the year, the total being only £308,681, as against £1,187,224 in the corresponding period of last year and £556,500 in the first seven months of 1893.

CONTRACTS OPEN AND CLOSED.

OPEN.

Cowes.—August 27th. Tenders are invited for laying down electric lighting plant of sufficient capacity to supply at the same time 2,200 8-C.P. lamps, also public lighting and the laying of mains to accommodate 3,000 lamps. Details can be obtained from Mr. N. F. Dennis, engineer to the Council, Cowes.

Germany.—August 24th. Tenders are being invited by the municipal authorities of Strasbourg for the supply of an electric travelling crane.

Hammersmith.—September 4th. The Vestry wants complete schemes for public and private lighting and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Particulars may be obtained from Mr. H. Mair, surveyor to the Vestry, between 9 and 5 (Saturdays, 9 and 1) on payment of £10, which will be returned to persons sending in a *bona fide* tender.

Holland.—Tenders are being invited until the 21st inst. by the Dutch Minister of the Colonies for the supply of a large number of iron telegraph poles. Tenders to be addressed to the Technical Bureau, Ministry of the Colonies, The Hague.

Islington.—August 27th. Tenders are wanted for the wiring of the Vestry Hall and Municipal Offices, and for the supply of fittings.

Killarney.—August 30th. Tenders are wanted for wiring the Killarney District Lunatic Asylum; supply will be obtained from the high tension mains of the Killarney Electric Lighting Company.

Portsmouth.—August 27th. Tenders are wanted for wiring and lighting by electricity the police stations at Buckland, Southsea, Portsmouth and Portsea. Full particulars can be obtained from the Town Clerk at the Town Hall.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—October 2nd. The municipal authorities of Braila, Roumania, are inviting tenders until October 2nd next for the concession for (*a*) lighting about 64 kilometres of public streets by both gas and electricity, and (*b*) 64 kilometres of public streets by electricity alone. They are also inviting tenders for the concession for the construction and operation of a network of electric tramways in the principal thoroughfares of the town. Tenders to the Maire, Hotel de Ville, Braila.

Stanningley (Leeds).—August 17th. Tenders are wanted for the construction and erection at Stanningley, Leeds, of a first-class polished compound steam engine, to drive 350 indicated horse-power, 85 lb. boiler pressure. Specification may be obtained at the office of Mr. John Waugh, C.E., Sunbridge Chambers, Bradford, on payment of £1 1s.

Vienna.—November 14th. The Municipality of Vienna ask for tenders and plans for the construction and working of electric railways in and around the city. The notice may be seen at the Commercial Department of the Foreign Office.

Wakefield.—The Corporation Electric Lighting Committee invites tenders for the supply and erection of boilers, engines, alternators, switchboards, cables, transformers, arc lamps, &c., &c., for the intended electric lighting installation.

CLOSED.

Egypt.—A contract has, it is stated, just been given to Messrs. Brown, Boveri & Co., of Baden, Switzerland, for the supply of some additional plant for the central stations at Alexandria and Cairo, Egypt.

Hampstead.—The tender of Messrs. Sydney Newton and Co. (£12) has been accepted for the installation of electric light at the Free Public Reading Room at Stanfield House, High Street.

CITY NOTES.

Waterloo and City Railway Company, Limited.

The half-yearly ordinary general meeting of the Waterloo and City Railway Company was held on the 9th inst. in the board room at Waterloo Terminus, Mr. Wyndham S. Portal presiding.

The Chairman, in moving the adoption of the report to June 30th, said that since they met, six months ago, they had been actively engaged in continuing the work of constructing the railway. The result had been, of course, a very considerable increase in the capital expenditure, much in excess of that of the previous half-year. The outlay for work and properties during the period under review amounted to £47,256, as compared with £2,626 up to December last year. In February last he informed them that progress was being made both in the up and down tunnels, and that there was every prospect of further advancement as the work was proceeding without interruption of any kind. Negotiations were in progress for the terminal stations, the contracts for which would be shortly let, and the works commenced before the end of the year. The probable further outlay within the current half-year rendered it necessary to make a call of £2 per share upon the 54,000 shares of the company, payable on July 1st. Negotiations with the District Company did not retard their operations for more than one week. They did not object to that, because the District Company were perfectly within their right in protecting their shareholders, and every consideration had been shown them in the matter. In conclusion, he congratulated the shareholders upon the future prospects of the line, and the engineers and contractors upon the marked progress they had made during the comparatively short period they had been engaged on the work. One and all entertained the hope that there would be really no difficulty in projecting this line.

The motion was seconded by Sir Algernon West.

A Shareholder asked whether the directors would call up the whole of the capital on the next occasion.

The Chairman replied that they would not. They could not do so, for the simple reason that they did not want the money. The rule hitherto adopted with regard to calls must be adhered to.

The report was adopted.

Crompton & Co., Limited.

The annual general meeting of the shareholders in Crompton & Co., Limited, was held on Friday last, at the City Terminus Hotel. Viscount Emlyn presided, and in moving the adoption of the report expressed regret at the unfortunate reduction shown in the profit. Although there had been considerable reductions in prices during the period covered by the report, yet probably the decline of profits was attributable more to the falling off in orders during the earlier period of the year than to the reduction of prices. During the first six months of the year business was so slack that practically no profit at all was made in that period, the whole of the £7,000 profit shown in the balance-sheet having been virtually earned during the latter half of the year, when the order-book was well filled and the works were kept extremely busy. This satisfactory state of affairs still continued, and several good contracts had recently been taken at higher prices, which justified the directors in looking forward to better results in the current year. There was no doubt that a healthier tone prevailed in business generally, and particularly in the electrical branch. During the year the directors had effected several changes in the working of the company with a view to future economies. He alluded last year to the satisfactory amount of orders received from Sydney for the Australian Company, but it subsequently transpired that the contracts which the manager of that company had made were most unfavourable, involving a system of deferred payments. The Australian Company, therefore, soon found itself in difficulties, but as Crompton & Co. were the largest creditor and debenture-holder, the directors were able to secure the appointment of the secretary as receiver. It was hoped that the debenture-holders and secured creditors would be paid in full. There was undoubtedly a considerable amount of business to be done in Australia, and Mr. Albright was about to proceed to Sydney to make arrangements, if his investigations should be satisfactory, for a continuance of the company's business there. Their arc lamp department continued to show very excellent results. They had reason to believe that the period of depression in their business was passing away, and that the future promised considerable and satisfactory improvement.

Mr. R. E. B. Crompton seconded the motion, which was adopted.

Lord Emlyn afterwards intimated that, owing to his recent appointment as chairman of the Great Western Railway Company, he would have to retire from this company, as he would not in future have any time to devote to it.

Manchester Edison-Swan Company, Limited.

The thirteenth ordinary general meeting of this company was held on 8th inst. at the company's works, Broadheath, Mr. V. K. Armitage, the chairman, presiding. The report and balance-sheet for the year ending May 31st, showed that the net profit, including last year's balance, amounted to £1,590, which it was proposed to appropriate as follows:—To payment of dividend at 5 per cent. per annum, £1,303; balance to be carried forward, £287.

The Chairman, in moving the adoption of the report and balance-sheet, said that the document was one which they submitted with a considerable amount of satisfaction. Although the last 12 months had been a period of very great trade depression, as the shareholders were aware, the company were still able to return to what prior to

last year was their ordinary course, and to recommend a 5 per cent. dividend, which he considered a very satisfactory state of affairs. Their gross profits had been £5,877, as against £5,200 in the previous year, and the net profit £1,590, as against £1,334 last year. In addition to that, they had taken off as depreciation £591, as against £226 last year, so that they showed a trade improvement of £614 over the trade of 1894. The directors attributed that almost entirely to the additional work they had got in the Altrincham lighting station, which the shareholders had just had an opportunity of looking through. The directors had no doubt that in the future they would find a very great advantage from their connection with the Altrincham and Bowdon Company, and from the increased facilities they had in their Broadheath manufacturing works. Since the end of May last they had obtained additional orders to the amount of £73,000, which he considered very satisfactory. The chairman proceeded to refer to items in the general balance-sheet, and said that with regard to the Altrincham Company, it was not well to prophecy too soon, but everything pointed to their connection with that company proving a very considerable success. They had already the equivalent of 6,349 8-candle-power lamps in their circuit, a much larger number than they anticipated, and they looked forward to a considerable increase during the coming winter. There was every inducement of its being a very successful concern, and to its helping materially the Edison-Swan Company in its business. With regard to the proposed reduction of capital, he said their shares had been at a discount in the market, and he attributed it entirely to their very large uncalled up capital and the liability upon the shares. It was intended in a short time, and when the legal preliminaries had been concluded, to ask the shareholders to sanction a reduction of capital by a very considerable amount, thereby reducing their liability. Considering that they were going to pay a dividend of the amount proposed, he saw no reason, when their large liability was materially reduced, and when they were able to show that the Altrincham and Bowdon Company, in which they placed the greatest confidence, was also likely to be a success, why their shares should not stand in the market at something like the value they represented.

Mr. W. P. J. Fawcus, the managing director, seconded the motion, and gave details as to the increasing work which was being done by the company.

The resolution was passed.

The Chairman moved a resolution declaring a dividend of 5 per cent., the surplus of the profit to be carried forward.

Mr. F. B. Ross seconded the motion, which was adopted.

Mr. V. K. Armitage, the retiring director, was re-elected, on the motion of Mr. I. C. Waterhouse, seconded by Mr. J. Collins, and the auditors, Messrs. Jones, Crewdson & Youatt, were also re-appointed.

The meeting terminated with a vote of thanks to the Chairman.

The Liverpool Electric Railway Company, Limited.

The fourteenth ordinary half-yearly general meeting of the shareholders of the Overhead Electric Railway Company was held at the Law Association Rooms, Cook Street, Liverpool, on Tuesday, 13th inst., Sir Wm. Forwood, chairman of the Company, presided, and there was a good attendance.

The Chairman, in moving the adoption of the report and accounts, remarked that they were of a most satisfactory and encouraging nature. The accounts related to what he might call the poor half of their year, the traffic during the first six months being, in their experience, always considerably less than the traffic of the second half of the year. In the first six months they had to depend on the business traffic of the line, except during the Whitsuntide period, when they obtained additional holiday traffic. In the second half of the year they had the summer months, and the period when they got the greater part of their holiday and excursion traffic. Therefore the figures for the past half-year, as compared with those for the corresponding half of last year, were most satisfactory. The number of passengers carried had increased from 2,861,437 for the half-year ended June 30th, 1894, to 3,460,000 for the past six months. There had also been a gratifying increase in the number of first-class passengers, the figures having gone up from 277,653 to 400,260. The increase in second-class passengers was also satisfactory, being from 1,246,975 to 2,114,462. Some remarks had been made as to the decrease in the number of workmen's special return tickets. These during the past half-year numbered 945,338, against 1,336,809 in the corresponding half of 1894, showing a decrease of 391,000. This was not, however, an indication of any smaller traffic under this head, but arose from the fact that the company did not now issue workmen's tickets after 8 o'clock in the morning. They also charged 3d. for return workmen's tickets in place of 2d., as formerly. Therefore, what they lost in cheap return tickets to workmen, they were gaining by an increase of second-class traffic, as the figures he had just quoted showed. So far as their traffic was concerned, the figures showed a continued and satisfactory increase; and the same might also be said of their revenue account. The receipts from passengers amounted to £27,708 6s. 1d., and from other sources they had £434 17s. 10d. Deducting from this £18,653 18s. 1d. for working expenses, and £2,500 for interest on mortgage debentures, left £6,989 5s., to which had to be added £1,087 12s. 5d carried from the former half-year, leaving available for dividend the sum of £8,076 17s. 5d. Part of the expenditure had been incurred in the increased mileage run by their trains, amounting to 46,000 miles. They had also worked 16 stations instead of 14, which had entailed some additional expense. The traffic, he was glad to say, had continued to progress since the accounts were made up. During the six weeks which had elapsed since June 30th, the traffic had increased by 55,000 passengers, and they had taken £1,668 more in money than during the corresponding six weeks of last year. From the £8,076 17s. 5d. available for dividend, the directors recommended the payment of dividends at the following rates (less income-tax):—5 per cent. per annum on preference shares, absorbing £2,529 0s. 9d.; and 2½ per cent. per annum on ordinary shares, absorbing £4,244 17s. 9d.; leaving a balance of £1,302 18s. 11d. to be carried to the next account. Looking at the figures in the report somewhat in detail, he found that their receipts had averaged 1·92d. per passenger, against 1·56d. in the corresponding half-year of 1894. This was due partly to the changes they had made in workmen's tickets, and partly to the increased use made of the line by working men. There was also a satisfactory decrease in the ratio between revenue and expenditure. The long frost of the past winter was particularly trying to their motors, with the result that they had a good many repairs to make, which had in consequence brought up their working expenses. The increased revenue per train mile during the half-year was 3·55d., whilst their expenditure, as would be seen from the report, was comparatively small. He assured the shareholders that they were working the line with efficiency, economy, and regularity, which was a matter of great importance in a business city. The punctuality of the trains would be realised when he stated that about 97 per cent. of them during the past half-year had been absolutely up to time, and last week every train on the line was punctual, notwithstanding that it was the holiday week. The physical condition of their structure was never better than at the present moment. The permanent way was also in a most excellent condition, and had never been better than now since the line was opened. The directors of the company were not only well satisfied with what they had done in the past, but they had every reason to take encouragement for the future. The contracts for the southern extension had been let at a figure within the estimate made by their engineers, and the work of construction was now in hand. They believed that the extension would be completed within the specified 12 months. The directors begged to thank the shareholders for the handsome way in which they had come forward and taken up the ordinary and preferred shares issued to meet the cost of the southern extension. The subscription was more than double the number of shares they had to allocate, and he was glad to think that they would be able to complete the work without issuing any bonus whatever. They were satisfied that the new extension would bring them in a large percentage of traffic.

Mr. J. Barrow seconded the motion, which was carried, as was also a proposition for the payment of the dividends mentioned by the chairman.

Mr. S. Stitt moved a vote of thanks to the chairman, and expressed his belief that as each succeeding year passed, the shareholders would receive increased dividends from the concern.

The motion was agreed to, and the Chairman, in acknowledging the compliment, said he had always been sanguine as to the success of the undertaking. The shareholders had a most excellent property in the Liverpool Overhead Railway.

The proceedings then terminated.

The Hong Kong Electric Company, Limited.

The yearly meeting of the shareholders was held on June 22nd, when the report and accounts were adopted after some little discussion.

The Chairman was able to show that considerable progress had been made, though the company were handicapped by the high price of coal and some damage done to the works by a typhoon. They had, however, been able to renew their coal contracts on more favourable terms, and had made numerous installations.

In reply to a question, the Chairman said the directors had received no remuneration for five years, but they would be happy to find themselves justified in taking it. Probably next year will see them in that position.

Mr. J. J. Bell-Irving's appointment to the board in place of Mr. Keswick was confirmed, and the retiring directors were re-elected.

Guildford Electricity Supply Company, Limited.—The prospectus, which was issued last week, of this company, invited subscriptions for an issue of 2,400 ordinary shares of £5 each. The nominal capital is £20,000; £1,500 has already been found by the directors and their friends. The object of the company, as the name signifies, is to supply electricity for public and private lighting, motive power, &c., in the borough of Guildford. It is estimated that 6,000 8-C.P. lamps will obtain a revenue of £3,000, and that from motors, cooking, heating, &c., a further £500 may be expected. A contract has been provisionally arranged between the company and Messrs. Sharp & Kent.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 11th, 1895, amounted to £860; week ending August 12th, 1894, £897; decrease, £37; total receipts for half-year, 1895, £5,084; corresponding period, 1894, £5,203; decrease, £119.

The Great Northern Telegraph Company. The traffic receipts in July, 1895, were £25,600; January 1st to July 31st, 1895, £174,800; corresponding months, 1894, £155,400; corresponding months, 1893, £156,800.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending August 11th, 1895, amounted to £1,578; corresponding week last year, £1,257; increase, £321.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 9th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,725.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation August 7th.	Closing Quotation, August 14th.	Business done during week ended August 14th, 1895. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	...	...
1,912,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	47 — 49	47 — 49	48⅜	48
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	88½— 89½	88 — 89	89¼	88⅜
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	8½— 9	8½— 9	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	13¾— 14¼	13⅞— 14¼	14⅛	13⅞
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —165	160 —165	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	.	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9¾— 10½	9¾— 10½	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106%	103 —106 xd	...	...
60,710	Direct United States Cable, Ltd.	20	3⅓% §	2⅝% §	2 %	9¼— 9⅜	9 — 9⅛	9 7/16	9¼
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6⅓% §	6½% §	6⅛%	17⅛— 17⅜	17 — 17⅛	17⅛	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	17¾— 18⅛	17¾— 18⅛	18 3/16	18 1/16
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	105 —108 xd	105 —108	...	...
1,297,837*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	126 —129	126 —129	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17⅜— 17⅝	17⅜— 17⅝	17⅝	17½
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106	102 —106 xd	105½	104¼
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106	103 —106 xd	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	127 —130	125 —128	...	...
80,600*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106	102 —106 xd	104	...
107,600*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	105 —108 xd	105 —108	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115%	112 —115	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4½%	10½— 10⅝	10⅛— 10⅜	10⅛	10 3/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	17⅜— 17⅝	16⅞— 17⅛xd	17¼	16 15/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝% §	8⅝% §	8⅝%	21⅜— 22¼	21⅜— 22¼xd	...	...
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	105⅜	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	49 — 52	50 — 53	51¼	51
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	1½%	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	6 %	6 %	6 %	107 —111	107 —111	...	...
28,000	Monte Video Teleph. Co., 6% Pref., 1 to 28,000 ...	5	*nil*	4 %	...	1½— 2½	1½— 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	6⅜— 6⅝	5⅞— 6⅛xd	6¼	6 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18 xd	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 16	15 — 16 xd	16	15¾
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6¼	6 — 6¼xd	6⅛	..
1,100,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —107	105 —107 xd	106⅝	106½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4½%	9/16— 11/16	9/16— 11/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	3½— 4½	3½— 4½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	126 —131	125 —130	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2½— 3	2½— 3	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	92 — 97 xd	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½— 6½	5½— 6½xd	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	106½	105½
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —104	99 —104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10½— 11	10½— 10¾	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6½— 7	6⅞	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4¼— 4⅜	4¼— 4⅜	...	...
165,200*l*	Do. do. do. 6% Debs. "A," 1880 Red.	100	6 %	6 %	6 %	101 —105 xd	101 —105	...	...
206,400*l*	Do. do. do. do "B," do.	100	6 %	6 %	6 %	101 —105 xd	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	⅛%	⅜— 1	⅜— 1	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10 — 10½	10⅜	10 5/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½— 9½	8½— 9½	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	110 —113	110 —113	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$100	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½— 5⅝	5½— 5⅝xd	5⅝	5½
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	...	...	...	... ...	6¾— 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	... ...	115—117	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14½— 15	14½— 15½	15⅞	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16½	15½— 16½	16 3/16	16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —134	131 —134	133½	133¼
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8½— 9½	9 — 10	...	...
10,000	Do. do. do. 6% Pref., £4 pd., 40,001—50,000	10	...	...	...	6 — 6½	6½— 7	6½	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅜— 7⅝	7⅜— 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2⅛%	3 %	10⅜— 11⅛	11 — 11½	11⅜	11 1/16
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	116 —119	116 —119	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½— 9	8½— 9	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8 — 8⅛	8 — 8⅛xd	8 7/16	8 1/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 10	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7⅞— 8⅛	8½— 8¾	8⅝	7¾
8,000	Do. do. do. Ord., 60,001 to 68,000 ...	5	...	...	...	7⅞— 8⅛	8½— 8¾	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Aug. 7th.	Closing Quotation, Aug 14th.	Business done during week ended Aug. 14th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2 — 2⅛	2 — 2¼	2 3/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2⅛ — 2⅜	2 — 2¼	2¼	2 3/16
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000	City and South London Railway	Stock	6/8%	6/8%	1¼%	41 — 43	41 — 43 xd	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	1 — 2	1 — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	2 — 2⅛	2 — 2⅛	2⅛	2
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	4½%	104 —107	104 —107	104	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	⅜— 1	⅜— 1	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2 — 2⅛	2 — 2⅛	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	7/8 — 1 1/16	⅜— 1	7/8	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	5/8 — 1 1/16	5/8— 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼— ⅜	¼— ⅜	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	10½— 11½	10½— 11½x	...	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15 — 15½	15 — 15½	15½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	104 —107	104 —107	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 21	19 — 21	20⅜	19¾
20,000	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	10 5/16— 10⅜	10½— 10½x	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15½— 16	15 — 15½x	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45 xc	44½	44
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107 x	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜— 4⅝	4⅜— 4⅝	4⅝	4½

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 95—100.

House-to-House Company (£5 paid), 3⅜—4¼.

Do. do. 7 % Preference, of £5, 8—8½.

Do. do. 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7½—8; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.

Liverpool Electric Supply, £5 (fully paid), 7½—7⅝.

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5⅜—6¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

INTERESTING EFFECT OBSERVED WITH THE VOLTAIC ARC.*

Two Brianne arc lamps were installed at Havre in front of a jewellery establishment in order to light up, at the same time, both the clock and the interior, and they were to be fed by the alternating current furnished by the central station of the "Havre Electrical Energy Company."

This current had a mean electromotive force of 60 volts, and was derived from a transformer fed by a primary current of 2,400 volts.

This difference of potential of 60 volts being too high to obtain a normal rate of working from a single lamp, and being, besides, too low for working two lamps in series, this difference of potential was reduced to 45 volts by the introduction of self-induction resistances on the secondary circuit, and the two lamps were connected in parallel.

Each absorbed 10 ampères when burning normally. The upper carbons of the lamp had a section of 14 millimetres and the lower carbons of 10 millimetres.

Lastly, these carbons were arranged in the centre of a large globe of transparent glass, one-half of which had been silvered inside, so as to become converted into a *hemispherical reflector*.

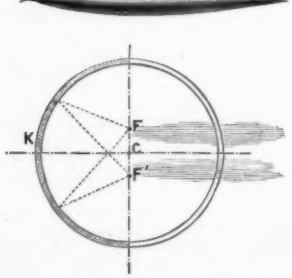
The exterior of that part of the globe that formed the hemispherical reflector was covered with an opaque varnish, which completely hid the light on that side.

We have had to give all these preliminary details in order to facilitate the explanation of the curious phenomenon that we are about to describe.

When we made the first trial of these lamps in their reflecting globes, they worked at first very regularly, furnishing a satisfactory light for lighting the clock and the shop; but, after about half an hour, there was a sudden brief extinction of each of the two lamps, to which, at first, no great importance was attached.

But half an hour later another extinction occurred, followed, as before, by the immediate relighting of the lamps.

On examining the carbons, we were surprised to find that they were considerably reduced in length; it was evident that this abnormal combustion was far from being in proportion to the duration of working. The lamps were put out, and at the bottom of each globe were found two little spindles of graphite, about 4 centimetres long, pointed at one end and hollowed at the other (fig. 1).



Figs. 1 and 2.

The presence of these spindles readily explained the cause of the apparently very rapid combustion of the carbons, and the successive extinctions of the arcs; but the cause of their formation seemed, at first, inexplicable.

* Albert Nodon in *L'Electricien*.

In order to ascertain the cause of this curious phenomenon, the lamps were made to work again several times in succession, their voltage and ampèrage being modified; but after each fresh trial four fresh spindles of graphite, exactly similar to the first, were found.

On studying this phenomenon more closely, we soon found out the cause of this abnormal combustion. In fact, the carbons occupied the centre of a hemispherical reflector, K (fig. 2), and, at the moment of lighting the focus made by the axis, was formed at a point, F, situated above the centre, C, of the sphere.

A *corresponding focus* was then formed by reflection at F', on the lower carbon.

The result of this was that the greater part of the luminous and calorific rays were concentrated at the point, F', and that the luminous focus, F, did not give out more luminous intensity than if it had burned with a naked light. The heat concentrated on the lower carbon soon became so great that the carbon became red hot, and began to be consumed at this point. The section of the carbon was consequently lessened by this combustion, the heating produced by the passage of the current in this resisting part was added to that furnished by the secondary reflection; and soon the section was reduced to a single point of contact, through which the arc was formed. At this moment the spindle became detached, and fell to the bottom of the globe in an incandescent state.

After the extinction produced by the separation of the spindle from the principal carbon, the action of the regulator brought the carbons in contact again, and the arc was again formed; but this time the arc was formed at F', at a point below the centre, C, of the sphere. A corresponding focus was then formed at F, and soon a second spindle detached itself from this carbon, and fell to the bottom of the globe by the side of the first.

When once the cause of this defective working of the lamps was known, it was easily remedied. In fact, the reflecting globes were abandoned, as they were found to have such a disastrous effect, and they were replaced by cylindrical reflectors with a parabolic section. The lamps were arranged so that the carbons occupied, with regard to the reflectors, an axis parallel to the generators of the cylinder, and passing through the focus of the parabola. As the luminous focus was variable, we thus arrived, by a simple method, at a system of lighting which was to all intents constant during the whole of the time that the lamps were in service.

The result of this alteration was a considerable increase in the light projected and the absolutely regular working of the lamps.

In conclusion, therefore, we will advise all those who wish to use a reflector for an arc light never to arrange the luminous focus at the geometrical centre of a *spherical* reflector; but we may add that there would be no objection to placing this luminous focus at the optical focus of the reflector, *i.e.*, at a distance from the top of the hemisphere equal to half the length of the radius of the sphere, so as to project the rays in a luminous sheaf to all intents cylindrical.

THE MEGOHM.

Mr. John Raworth is a ready writer. His letters are usually long; they teem with witticisms, or little pleasantries that pass as such; and his *similes* are often times apt. Generally speaking, his communications form amusing reading, and are very appropriate for the pages of comic papers, a fact which we feel sure Mr. Raworth appreciates most keenly. Mr. Raworth is, perhaps, too ready with his pen, and he will write defiantly, deprecatingly, satirically or jocularly, as the case may be, upon any subject from a steam engine to a megohm.

It does not matter whether the topic which raises his ire is one in which he has had special experience or not; nothing comes amiss when he feels pugnacious, and he is now waxing wrath over the unoffending megohm, whose utter demolition he ardently desires. Concerning the specification of insulated conductors, he says:—

> In the seventies and early eighties we had two kinds of conductors, viz., *bare* and *insulated*. The definition was simple but effective, and I formed the opinion, based on experience, that conductors gave no trouble except in paying for them.
>
> Then came the megohm. The megohm is primarily an invention of the devil, in the second place it is a million ohms, thirdly I have seen it in the "flesh," as a scarcely visible mark of a lead pencil on a sheet of ebonite. I hope I am not hypercritical, but if we must have megohms, let us have them in any form but the last. You may as well try to stop a mousehole with cheese as to choke volts with ebonite and plumbago.

We were under the impression that the megohm was an earlier creation; at least, we had used several in the identical shape described by Mr. Raworth, besides wire megohms, before he entered the electrical field of action; and when the pencil line was protected from atmospheric influences by varnish or lacquer, a very useful and approximately correct megohm we found it for our purposes. Needless to say, it was not used in a central station; in those days, neither central stations nor Mr. Raworth were in evidence.

Familiarity is said to breed contempt; this is doubtless true in a particular sense; but in Mr. Raworth's case it is *un*familiarity that has caused the outburst. Five-and-twenty years, or even less, *constant* experience of insulation testing and of handling the megohm would have modified Mr. Raworth's view on the matter. At the same time we must admit that the numerical distinctions which indicate the various qualities of insulation in manufacturers' lists are not, except to the experienced hand, particularly plain indications of the value of the various qualities, as the figures under each heading usually cover a great diversity of cross sections. It certainly would not be advisable to abolish "megohms per mile," but of the desirability of giving the value of the quadrant cube of the material in addition, we have little doubt. The latter, of course, is an exact comparative indication of the resistance of the material, precisely as percentage of conductivity is, and familiarity with it would soon enable anyone to grasp and appreciate its significance.

The suggestion that thickness of material is of much more value than megohms, fully indicates Mr. Raworth's failure to appreciate the real meaning of megohms, and because he fails to see it he condemns it. As well might a man condemn the higher mathematics because he has hitherto failed to soar higher than simple rule of three. What but experience would teach anyone that a rubber insulated cable having an insulation resistance of, say, 2,000 megohms per mile, was radically faulty, whilst one of similar dimensions insulated with gutta-percha, which had only a resistance of 1,000, was perfectly good. What but experience will teach the significance of "electrification," that in the best gutta-percha it is low, whilst in India-rubber it is high.

Mr. Raworth reminds us of the celebrated American physician to whom no case came amiss, but he took the precaution whatever the ailment might be (for he never diagnosed) to give the patient some of his wonderful elixir to bring on fits, because he was a "stunner" on fits. We would suggest that into whatever unknown path Mr. Raworth blindly plunges, he should come back by way of the steam engine, for there he is on safe ground. To such utterances as those to which we have referred we fear the cable makers will turn a deaf ear.

THE EFFECTS OF ELECTRIC CURRENTS IN IRON ON ITS MAGNETISATION.*

By JOHN HOPKINSON, Esq., M.A., D.Sc., F.R.S., M.R.I.

(*Concluded from page* 164.)

I am afraid I can only give you a very general explanation of the peculiarities of these curves. I will first of all throw upon the screen a diagram (fig. 9) showing what are known as cyclic curves of magnetisation. The vertical ordinates represent the induction, and the horizontal abcissæ the magnetising force. You will observe that when the magnetising force is small, the ratio of induction to magnetising force is also small; that as the magnetising force increases this ratio is also increased for a time, but that, finally, it again becomes small. You will observe, further, that when the mag-

* Lecture delivered before the Royal Institution, April 26th, 1895.

netising force is great the curve of magnetisation begins with a small rate of change, which then becomes large, and which again becomes finally small. Now the slowness of changes of induction depends upon the largeness of the ratio of induction to magnetising force, and, therefore, we should expect that when this ratio is small the changes would occur with comparative rapidity, and that when it is large they would occur more slowly. This is exactly what we have seen. With a small force the change shows itself almost at once; with an intermediate force the principal maximum occurs much later, and with a large force it is continuously being accelerated as the force becomes larger. The first rise that occurs with a large force is due to the early part of the curve of induction, where changes of induction are comparatively small, and where consequently the effects rush in rapidly. This first maximum is followed by a time of comparative quiescence, which is again succeeded by a second and large maximum caused by the full effect of the great changes of induction which have occurred, but which have passed in comparatively slowly; and then, finally, the change drops away to zero quite suddenly, owing to the great rate at which the last part of the change has rushed in and pressed upon the parts which had occurred before it.

These phenomena of the times at which changes of induction occur in the cores of electro-magnets have a close analogy to the retardation of signals upon cables. Many of you know if a battery is connected to a submarine telegraph cable, and if its connection is suddenly reversed, that the current throughout that cable is not reversed at once, but that it takes an appreciable time before the effect is perceptible at the far end of the cable. This retardation of the signal, as it is called, rapidly increases with the length of the cable. I will first of all show you two curves of arrival, as they are called, of the current in a cable (fig. 10). In these curves the ordinates represent the currents, and the abscissæ represent the times. You will observe that there are two curves shown; one is for a length of cable double the other, the longer cable giving the slower times.

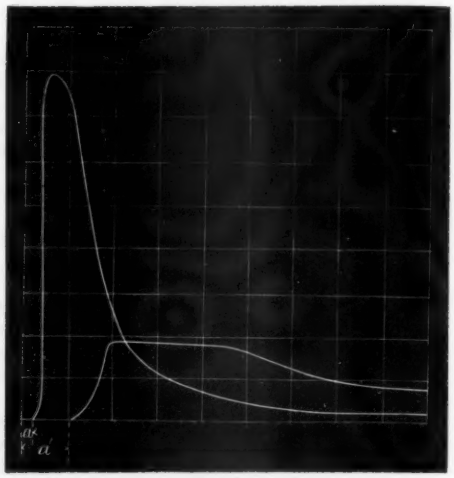


Fig. 11.

sufficient to suggest an analogy between the phenomena which actually exist. I can show you the same thing in another way. There are in the library one of Lord Kelvin's syphon recorders, made by Messrs. Muirhead & Co., which will be at work after the lecture, and also an artificial cable, which has also been made by Messrs. Muirhead & Co. Curves can be obtained from the end and middle of the cable.

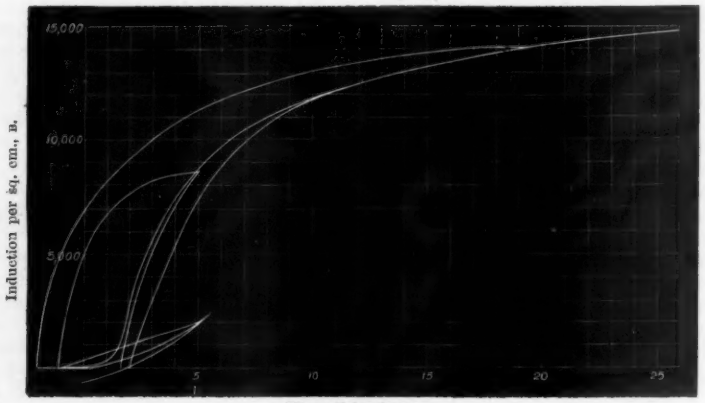


Fig. 9.

Now all that the curves in this form are capable of showing you is, that with the longer cable the events are more retarded. In order to make them really comparable with the magnetic experiments, we must show a curve in which the abscissæ represent, not the currents, but the rate of change of current. We have such a curve here

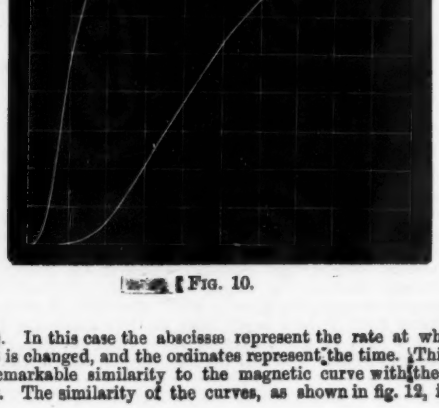


Fig. 10.

(fig. 11). In this case the abscissæ represent the rate at which the current is changed, and the ordinates represent the time. This curve has a remarkable similarity to the magnetic curve with the lowest current. The similarity of the curves, as shown in fig. 12, is quite

Magnetic experiments such as these have really a wide application. They are not restricted to the particular size of the cylinder upon which the experiment is made. If the cylinder is larger or smaller

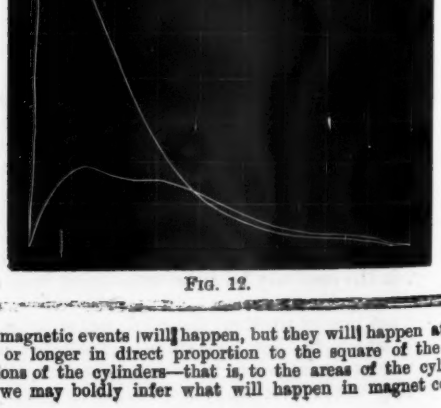
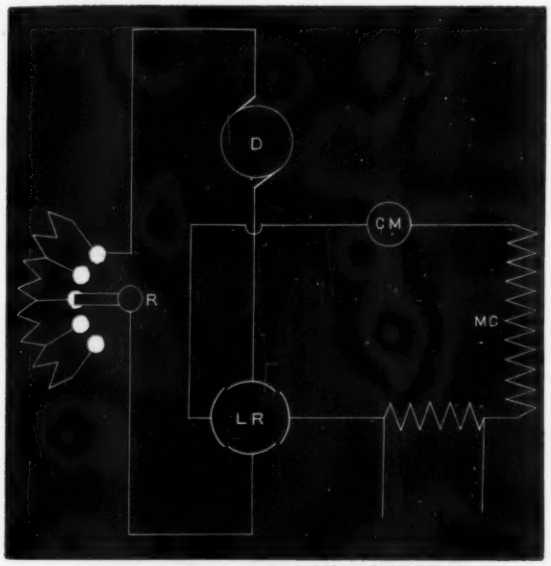


Fig. 12.

similar magnetic events will happen, but they will happen at times shorter or longer in direct proportion to the square of the linear dimensions of the cylinders—that is, to the areas of the cylinders. Hence we may boldly infer what will happen in magnet cores of

dimensions too small to experiment upon or so large that they would be very costly to make. For example, suppose a core is made up of wires $\frac{1}{100}$th of an inch in diameter, we may expect that everything will go on with the same currents around the core but 1,440,000 times as fast; with a force of 24, everything will be over at the centre of the core if the current is instantaneously reversed in $\frac{1}{60000}$th of a second.

One very practical application of these results is to the cores of transformers, but in this case we have not the sudden reversal of the magnetising current, but the current continuously varies from positive to negative and from negative to positive. It is not difficult to imitate these conditions on the slow scale which is suitable for our large magnet, but if I were to show you an experiment at an appropriate rate on the magnet which we used for reversals, I fear you would find the results intolerably tedious. It would take some minutes to get through a single reversal. I will, therefore, use a smaller magnet, 4 inches instead of 12 inches diameter, which will get through the business nine times as speedily. I will first of all throw upon the screen a diagram (fig. 13) which shows the method



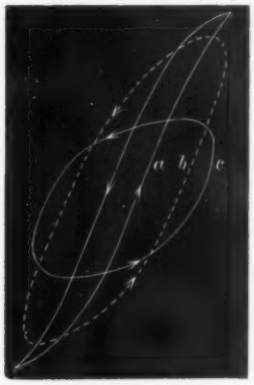
To D'Arsonval galvanometer.

D, Dynamo; C, M, Current meter; M, C, Magnet coil; R, rheostat; L, R, Liquid reverser.

FIG. 13.—PRIMARY CONNECTIONS.

of the experiment. Here is the source of electricity, marked "dynamo"; here are resistances for regulating the current, marked "rheostat"; and here is a liquid reverser intended to reverse the direction of the current by continuous steps. It consists of two copper plates, to which the current is taken, and of two moving plates revolving between these plates, which plates are connected to the electro-magnet. As the moving plates revolve, the current will diminish from a maximum in one direction to nothing, and will then increase to a maximum in the opposite direction. The electro-magnet is marked "magnet," the secondary coils of which are not indicated in the diagram. Only one coil in the centre of the magnet is connected. We will now turn the reverser faster. You see, the variations of inductions diminish greatly—indeed, the induction at the centre of the core is but little affected by the changing current in the magnetising coils (change leads). We might have tried three coils instead of one, but the experiment is a little confusing. If we had done so, we should have seen that the diminution of disturbance with increase of speed was less with No. 2 coil than with No. 1 coil, and that it had disappeared entirely with No. 3 coil, and we should further see that the current in No. 2 coil lay behind No. 3, and in No. 1 behind No. 2. I can show you the contrast more effectively with the Westinghouse transformer with a divided coil. This is now connected to the lowest galvanometer. We turn slowly, notice the deflection. We turn faster; you see the deflection is increased instead of diminished, as it was with the central coil of the solid electro-magnet. Experiments such as these are at once applicable to transformer cores and the cores of dynamo machines. They show that in practice manufacturers have divided the iron about enough, and not too much.

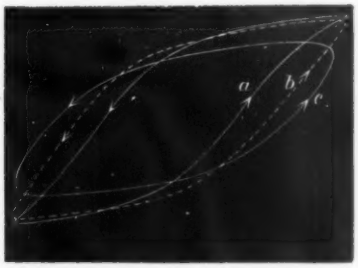
I have here on the table an instrument designed by Prof. Ewing for the purpose of describing the curves which express the relation between induction and magnetising force in iron. It served in Prof. Ewing's hands to illustrate the point which we have been discussing. I will throw upon the screen curves taken from Prof. Ewing's paper read before the Royal Society. The curves have been taken from solid samples of iron—I mean iron which is continuous, and not divided for the purpose of annulling the current in it. In the first curve (*a*, fig. 14) we have the result in which the cycle has been passed through very slowly, and is the true curve of magnetisation. We have *b*, where the cycle has passed through in three seconds—and you will observe that the amplitude of the induction has diminished, and we have, lastly, the curve *c*, where the period of the cycle is six-tenths of a second, and you will observe that it has much more diminished. This is owing to the fact that changes of induction in the centre of the iron hardly exist, and that therefore the total effect is materially diminished. The diagram (fig. 15) is for steel.



a, Cycle performed slowly; *b*, Period of cycle, 3 seconds; *c*, Period of cycle, 0·43 second.

FIG. 14.—MAGNETIC CURVE-TRACER CURVES FOR SOFT-IRON BARS.

We have *a*, the natural curve of induction; *b*, the case when the period of the cycle is three seconds; and *c*, when the period is four-tenths of a second. Curves such as these, of course, very readily give you the average effects upon the whole mass of the iron. The curves which I have shown you give the particular effects of different parts of the mass.



a, Cycle performed slowly; *b*, Period of cycle, 3 seconds; *c*, Period of cycle, 0·6 second.

FIG 15.—MAGNETIC CURVE-TRACER CURVES OF STEEL.

In conclusion, let us indulge in a little wild speculation, not because it is probable that it is in any sense true, but because it is interesting. Suppose a magnet were made exactly like the one on which we experimented, but of the size of the earth, and that some mighty electrician generated such a current in its copper coils as would give a magnetising force of 2·5, and then reversed it, it would take some thousands of millions of years before the rate of disturbance at the centre attained its maximum value. The speculation I suggest is this: Is it not conceivable that the magnetism of the earth may be due to currents in its material sustained by its changing induction but slowly dying away?

LONG-DISTANCE TRANSMISSION AT 10,000 VOLTS—THE POMONA PLANT.*

By GEORGE HERBERT WINSLOW.

(*Continued from page* 151.)

THE power house is 66 feet long by 30 feet wide, and has walls 12½ feet high. The walls, which are of concrete, were all built by tamping concrete in a space between temporary wooden walls forming a mould, a few feet of wall being built at a time, and the planks then loosened and raised to the height of the next section, the walls being thus made at the least expense for timber. The best English Portland cement was used. The walls were consolidated and cement saved by the use of well washed fragments of rock imbedded in the concrete. In order to obtain the greatest available fall the power house was placed as far as possible below the level of the fall. This necessitated blasting into the side of the hill so far that the entire wall next the hill was below the level of the adjoining rock. The wall was built against the rock, and consequently became damp as soon as the rainy season set in, but this did not affect the 10,000 volt bank of transformers set on a rack beside the wall.

* Read before the American Institute of Electrical Engineers, Niagara Falls, N.Y., June 27th, 1895.

The station was built to accommodate four 120 kilowatt 7,200 alternation 12 pole single-phase Westinghouse alternators, with their full complement of raising transformers and switchboard apparatus, and two exciters. The first installation consisted of one generator with one 90 ampère 125 volt "I" exciter, capable of exciting the four alternators, and of 126 kilowatt capacity of oil transformers in 21 units of 6 kilowatts, one of these units being kept as a reserve.

Several different methods of connecting the raising and lowering transformers were given careful consideration, the test of actual use favouring a series connection for both primary and secondary coils of both sets of transformers, a plan which has proved to be thoroughly reliable in its practical operation at the Westinghouse plant at Portland, Oregon. It was, however, decided, in order to be able to change the initial pressure on the line in case of accident to any of the converters, to connect the primary coils of the raising transformers in multiple to the dynamo, put the line coils all in series with the line and with a similar set of coils in the lowering transformers and connect the other coils of the latter in multiple to the distributing circuits.

The next question was what size of transformer should be used. Many small transformers meant less cost per unit for repairs, greater facility of handling and greater flexibility in case it were desired to change the voltage on the line. Their use, however, also meant greater first cost, more complication and somewhat lower efficiency, but these points were outweighed by the former and a transformer unit of six kilowatts was chosen. Each transformer is contained in a cast-iron box provided with vertical outside ribs, which serve to stiffen it and also to cool the oil with which the box is filled and which entirely covers the transformer. The box is covered by a cast iron lid, which has conducting and radiating ribs both outside and in, the inner ones dipping into the oil at its hottest part and helping to cool it. The oil when heated, rises through open spaces around the coils and spreads out in all directions, guided by the ribs on the lids and sinks slowly down between the core and the sides of the box, thus having ample opportunity to become cooled. Each box is provided with a pet cock at the bottom, by which to draw off the bottom layer or oil, should it become too thick for evaporation. It also has an oil gauge to show whether the tops of the coils are completely covered without having to raise the lid. The boxes are supported upon a substantial timber frame, upon the top of which two iron bands serve incidentally to protect the wood, but chiefly to metallically connect the boxes to each other and to the earth, in order to dissipate the static charge received by the boxes, which is very unpleasant. The core of the transformer is connected to the box by a copper strip fastened around a block of wood upon which the core rests in the box, and to provide against the danger which would result from accidental connection between the primary and secondary coils, an insulated sheet of copper is placed between the latter and close to the dynamo coil, and is connected to the core by a tongue which is stuck between the plates.

The line coil, of No. 7 Brown & Sharpe gauge wire, is inside the dynamo coil, and is kept everywhere at a distance of one-half inch from latter, the ground plate, and the core by walnut blocks boiled in paraffine, between which ample openings are left for circulation of the oil. The ratio of transformation is 1,000 to 450, so that in a bank of 20 transformers the dynamo pressure required for 10,000 volts, and on open circuit, is 1,110 volts and on full load about 3 per cent. more than this, or 1,140 volts. The space between the 1,000 volt coil and the core is $\frac{1}{8}$th of an inch. The terminals of the line coils are brought up through the oil in mica-fibre tubes passing through heavy glass bushings held in paraffined woodened blocks which are attached to the sides of the boxes. The 1,000 volt terminals are similarly supported, but without glass bushings. The transformers are all connected in multiple to the dynamo circuit, which is supported directly above them on a light pine framework, which also supports the fuse blocks. The latter are single-pole and the fuse passes through a hole in a marble block, the object of so confining the arc being to blow it out by its own force. Only one fuse is used on each transformer. The secondary or line coils are all connected in series by U-shaped insulated wire connections which may be readily detached when making periodical tests for insulation of terminals, and which are entirely independent of the framework supporting the dynamo circuit. Accidental contact with the exposed connectors is prevented by the framework above mentioned, and there is an inflexible rule that the high-tension side of the transformers shall not be touched under any circumstances whatever, while the dynamo is running.

Clark's insulation is used on all wires connected to the transformers and to the dynamo, and the terminal wires of the full bank, which must often be disconnected for testing, are further insulated by heavy glass tubes at points where they might come in contact with other wires. All other transformer wires are supported upon double petticoat glass insulators, and all dynamo wires upon porcelain knobs.

The switchboard is of narrow redwood boards, tongued, grooved, and beaded, nailed on a framework of yellow pine, the latter supported on porcelain insulators to keep it dry. The switchboard outfit for the one generator and one exciter consists of two 120 ampère fuse blocks, field rheostat with a 25 ampère dynamo pressure, field switch with fuses, one 150 ampère ammeter and a 200 ampère dynamo pressure jaw switch. From this switch the current passes to two four-dynamo marble switch panels which are connected in multiple to the dynamo, and are each provided with two pairs of contact plugs. By means of these panels and of the two 200 ampère dynamo changing switches below them any feeder can be operated from any dynamo which is connected to the switch panels. Between each panel and its switch is a pair of 65 ampère Wurts shunt wire fuse blocks, each provided with an extra fuse and shunt which can be connected by inserting a plug should it be desired to double the fuses during the run, on account of overload or of weakness in the fuse. The remaining instruments on each feeder are a voltmeter, a No. 1 switchboard converter and a 150 ampère type "E" compensator. When both feeders were run from one alternator, one voltmeter was connected to the generator and the other to the feeder, and in this way the amount of compensation could be watched.

The oil transformers were tested before shipment with 20,000 volts between the line coil and the core, and were then taken out of the oil and boxed. In order to expel any moisture which might have been absorbed by the insulation of the coils or have condensed on the cores during their long journey, the transformers were connected in two banks of ten each, the line coils of each set being connected in series to the generator, which was run at a reduced speed, and the secondary coils each short-circuited on itself. The coils were thus gradually heated to a point somewhat above the boiling point of water, which at that elevation was about 201 degrees Fahrenheit. They were kept at this temperature for a short time, and then paraffine oil of a special grade ("Diamond") was poured slowly into the boxes at the edges, so that the coils would begin to absorb oil at their lower ends, and thus drive upward the air and volatile gases occluded by the insulation. The transformers were then again brought to their former temperature, which caused expansion and partial expulsion of the air remaining in the insulation. Some of the air would, however, collect under the insulation at the top of the coils, and had to be freed by mechanical agitation, produced by stirring the folds of insulation or by pounding on the boxes. The heat caused volatilisation of some of the lighter elements of the oil, these coming to the surface as bubbles, just as the air did at first, and the agitation was kept up at intervals until bubbles from this cause also were entirely eliminated.

The 20 transformers then connected as they would be when in regular use, and the two terminals of the line coils, which were to give 10,000 volts, were connected in series with one hundred 100 volt lamps, which were then brought to full candle-power, showing that the transformers were all in good condition. A similar test was then made at Pomona at the end of the 14 mile transmission line running to that place, after which the transformers there were prepared for work in the same way as at the power house, except that the grouping and initial voltage were changed.

There are two transmission lines, one 13¾ miles long, which supplies Pomona, and another 28¾ miles long, which supplies San Bernardino. Each line consists of two No. 7 Brown & Sharpe gauge wires. The joints in the wire are made with McIntire connectors. To further improve the joint the ends of the wires were bent back side by side and soldered together. After the Pomona line was completed and the first 10 miles of the San Bernardino line was put up, the supply of connectors ran out, and the regular telegraph joint was substituted. The conductivity was assured by soldering as before. (See fig. 4.)

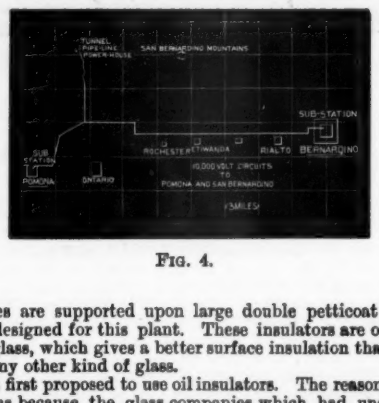


FIG. 4.

The wires are supported upon large double petticoat flint glass insulators designed for this plant. These insulators are of perfectly clear flint glass, which gives a better surface insulation than is attainable with any other kind of glass.

It was at first proposed to use oil insulators. The reason they were not used was because the glass companies which had undertaken to furnish them found on trial that they could not make them without considerable experimenting, which would have delayed the installation of the plant. This was no doubt fortunate, as the country through which the line passes is subjected to hot, dry winds which not only blow dust on to the insulators but also inside them, and during the day the sun beats on the insulators until they become so hot that they nearly blister one's hands. If oil were used under these conditions it would soon evaporate and thicken, and become filled with dust. It would, therefore, seem undesirable to have used oil insulators in this case, or to use them in any other until an increased voltage makes them necessary, and the transmission of greater amounts of energy over the circuits justifies the additional expense necessary to keep the insulators in good condition.

The inside pair of pins was used for the circuit to Pomona and the outside pair for that to San Bernardino, until after the acceptance of the plant, but in anticipation of the installation of another generator the Pomona circuit was changed to the right hand pair of pins, and the San Bernardino circuit to the left hand pair, to avoid the fluctuation in lights which would result from inductive interference between two independent circuits.

Commercial lighting in Pomona was begun November 28th, 1892, and a telegraphic order was at once sent for another set of reducing transformers, to be used at San Bernardino, where the local circuits were already nearly completed. It was a condition of the franchise for the latter place that lighting should be begun before January 1st, and work was pushed rapidly on the transmission line, over 28 miles long, until it was finished. The order for transformers had, however, been given too late for them to be delivered in time and it was

decided to reduce the pressure at Pomona to 5,000 volts and to take to San Bernardino the half of the Pomona bank thus made available. In order to avoid the re-heating which would have been required had the transformers been dismounted for shipment, the latter were hauled to San Bernardino on waggons without springs, after the lids had been packed so that the oil could not splash out. The transformers reached their destination after midnight and the next day, December 31st, they were connected to the transmission line for a few moments to see that the latter was all right, after which all the lights on the circuit were thrown on for the night.

When the new transformers arrived they were set up and heated in the same way as the others. The heating was continued night and day, until complete, without interrupting the regular lighting service. The change of both circuits to 10,000 volts was made February 16th, 1893.

The sub-stations at Pomona and San Bernardino are small brick buildings, one storey high, with flat tin roofs and numerous windows. The Pomona building contains two rooms connected by a door near the switchboard. The front room is used as the office of the company and the other as a transformer room. The 10,000 volt circuit enters over the door and is connected directly to the bank of lowering transformers, interest being that a considerable number of helios arc lamps are successfully used on the circuits.

While in use the transformers in the sub-stations give forth a continuous hum which depends for its tone on the number of alternations. This is an excellent indicator for the attendant, whose attention is instantly called to any change in the running conditions of the plant by the resulting change of tone. Its indications not only mark changes which are taking place and which can be detected on the voltmeter, but also give notice of coming changes before there is any other indication of them. It is thus possible to foretell a coming drop in voltage in time to use the regulator, and thus keep the voltmeter needle perfectly still, though the voltmeter is a very sensitive instrument and the regulator is often moved four or five notches. The hum often changes, however, without any corresponding movement of the voltmeter, but the sound is then somewhat different. At rare intervals the switchboard lights will suddenly change slightly in candle-power before any change is noticeable on the voltmeter.

It is noticeable that the needle will often stand for a time perfectly still on the centre, and, on a slight rise in the hum, will start gently rising, never more than $\frac{3}{4}$ of an inch, and then as the tone gradually becomes lower, slowly fall back to the centre and stop without pass-

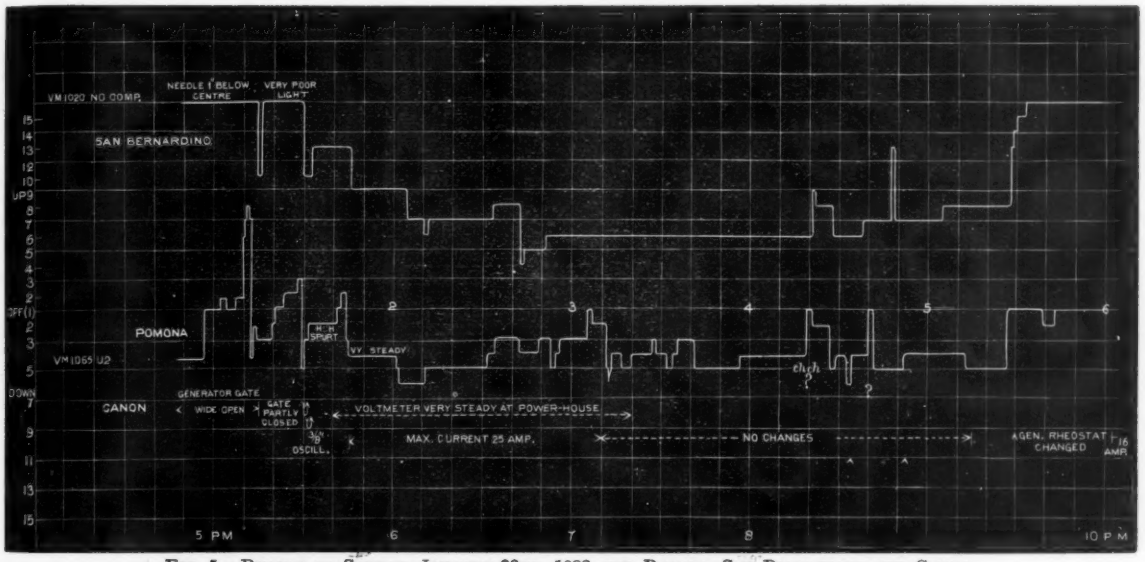


Fig. 5.—Record of Sunday, January 22nd, 1893, for Pomona, San Bernardino and Canon.

no switches or other appliances being used on the high-tension lines either there or at St. Bernardino. The switchboard appliances are a Stillwell regulator, two 100 ampère marble fuse blocks, with double plugs and fuses, 100 ampère jaw switch, 150 ampère ammeter, compensating voltmeter, compensator and converter.

The San Bernardino sub-station is longer than that at Pomona and is not divided by a wall. The transformers are placed in a row along a side wall and along part of the end wall next the switchboard. The transformers near the switchboard heat the most. This is probably due to the slight drop in wiring between them and the more distant converters. During the first year of operation a little new oil was put into the converters about every four months to make up for that evaporated, but none of the old oil was drawn off. The switchboard apparatus is like that at Pomona.

The Stillwell regulator has long been recognised as a valuable adjunct to the central station, operating a number of feeders of different lengths from a single dynamo. Its utility is still greater in a system of long-distance transmission in which, as was the case in this plant during its first year of operation, the transmission circuits are supplied from one dynamo, since it is not practicable to install such a system so as to operate with small line loss, and, therefore, means must be provided to compensate for the large differences in the pressure at the ends of the lines. The use of regulators at the power house was impossible while but one bank of raising transformers was used for the two circuits. Even when it became possible by the use of separate banks of transformers, it was still undesirable because the attendant at the power house would often have to work both the regulators simultaneously to properly compensate for changes in load, and his attention would be required by the regulators at exactly the time he should be free to attend to the generators and water wheels. A regulator was therefore placed at each sub-station as already stated. These are each of 2,000 lights capacity and have a range of 10 per cent. up and 10 per cent. down. This variation of 10 per cent. (100 volts) is divided into 14 equal parts, so that each step corresponds to 7·1 volts. The diagram (fig. 5) is taken from the station records for Sunday, January 22nd, 1893, and shows the number of changes required during the evening at each station. The line marked "off" is the base line, and the divisions above and below correspond to the steps on the dial and show to what an extent the regulators were used to increase or decrease the pressure. This diagram shows how impossible it would be to furnish lights without using regulators, even on Sunday, when the load is much smaller than on other days.

The distribution from both sub-stations is effected in the usual manner at 1,000 volts for incandescent lighting, the only point of interest being that a considerable number of helios arc lamps are successfully used on the circuits.

While in use the transformers in the sub-stations give forth a continuous hum which depends for its tone on the number of alternations. This is an excellent indicator for the attendant, whose attention is instantly called to any change in the running conditions of the plant by the resulting change of tone. Its indications not only mark changes which are taking place and which can be detected on the voltmeter, but also give notice of coming changes before there is any other indication of them. It is thus possible to foretell a coming drop in voltage in time to use the regulator, and thus keep the voltmeter needle perfectly still, though the voltmeter is a very sensitive instrument and the regulator is often moved four or five notches. The hum often changes, however, without any corresponding movement of the voltmeter, but the sound is then somewhat different. At rare intervals the switchboard lights will suddenly change slightly in candle-power before any change is noticeable on the voltmeter.

It is noticeable that the needle will often stand for a time perfectly still on the centre, and, on a slight rise in the hum, will start gently rising, never more than $\frac{3}{4}$ of an inch, and then as the tone gradually becomes lower, slowly fall back to the centre and stop without passing it. At other times the variation in hum is more sudden and the needle will rise and oscillate above the centre. Again, the needle will oscillate equally about the centre during a regular rise and fall of hum, its movement being apparently due to one impulse and not seeming to be modified by subsequent variations. There is no apparent change in candle-power of the lamps during the voltmeter changes noted. These notes were made while the plant was running at only 5,000 volts, but they were later confirmed when using 10,000 volts. During dry weather there is considerable intermittent oscillation of the voltmeter needle without there being any change in load or any other apparent cause, while in wet weather the needle remains perfectly still for many minutes at a time, for often as much as half-an-hour. A possible explanation of this oscillation may be found in the presence of static charges on the line, due to atmospheric electricity. That the line is often heavily charged from the air is shown by a number of observations. One afternoon a painful shock was obtained on touching the line at the canon end, drifting clouds and a strong wind being noticed in the valley. Again, while using the telephone a report was heard in it so sharp as to cause momentary deafness. Later, after a moderate wind had been blowing for some time, loud reports were noticed on the telephone at long intervals. As the wind became higher the reports came oftener and the intervals between the reports became shorter. It was evident that there was a discharge from the lines through the telephone, which was on a metallic circuit, and that it depended on the rate at which the wind blew. In order to get the strongest effect the two wires were connected in the usual way to the raising and lowering transformers, and one side of the telephone connected to one wire. On connecting the other side of the telephone to ground a sharp report was heard, and on maintaining the connection there was a sound as of steam escaping at a distance, with intermittent and very faint crackling. If the ground contact was made slowly there was a bright spark before the metals touched and a loud report. If the fingers were interposed a smart shock was received. By making and breaking the ground connection rapidly, the line was prevented from accumulating a heavy charge and no spark was visible, though a faint crack was heard. If a slight space was left between the telephone wire and the ground, a spark occurred at fairly regular intervals, and when the space was lessened the sparks become smaller and more frequent. When the wind lessened the sparks and reports became almost imperceptible, but on the wind becoming strong and blustery a large spark was again obtained. When one line wire was disconnected from the transformers at Pomona the effect obtained from grounding that wire was less owing to the reduction in capacity.

(To be continued.)

NEW PATENTS—1895.

14,355. "A non-rotating terminal for wire or cable connections to electrical instruments and the like." C. Berry. Dated July 29th.

14,360. "Improvements in bayonet-joint holders for incandescent electric lamps." J. H. Pentland. Dated July 29th.

14,393. "Improvements in voltaic batteries." D. G. FitzGerald. Dated July 29th.

14,396. "Improved means for telegraphing copies of writing, drawing, and the like." A. B. Hutchings and R. J. Crowley. Dated July 29th.

14,403. "Improvements in or connected with electrical gas-igniting devices." J. Jahnsson. Dated July 29th.

14,446. "A combined astatic and dead-beat galvanometer especially for use on board ship." T. Clark. Dated July 30th.

14,473. "Improvements in and relating to electric clocks." W. S. Scales. Dated July 30th.

14,476. "Improvements in transmitting and receiving attachments for telephones." H. W. Libby. Dated July 30th.

14,481. "An improvement in imitation candles for electric lights." T. G. Pocle and W. Lowry. Dated July 30th. (*Complete.*)

14,485. "Improvements in alternating current arc lamps." J. Devonshire. (Communicated by C. E. Harthan, United States.) Dated July 30th. (*Complete.*)

14,492. "An improved arc regulator for electric lamps." S. Prieto. Dated July 30th. (*Complete.*)

14,493. "Improvements in electromotors and dynamos." T. D. Hollick and F. W. Hollick. Dated July 30th.

14,577. "Improvements in multiple circuit dynamo-electric machinery." C. B. Crawshaw and R. Kennedy. Dated August 1st.

14,589. "Improvements in starting switches for electromotors and in apparatus therefor." C. B. Crawshaw and R. Kennedy. Dated August 1st.

14,615. "New or improved device applicable for use in connection with telephones." E. Delaney. Dated August 1st.

14,627. "Improvements in electric fire alarms." A. C. Brown and G. R. Neilson. Dated August 1st.

14,638. "Improvements in electric brakes" J. C. Chapman. (Communicated by W. B. Potter, United States.) Dated August 1st. (*Complete.*)

14,639. "Improvements in safety appliances for electric cars" J. C. Chapman. (Communicated by W. B. Potter, United States.) Dated August 1st. (*Complete*)

14,676. "Improvements in shade holders for electrical and other lamps." H. Hirst and W. E. Gibson. Dated August 2nd.

14,709. "Improvements in electric arc lamps." W. J. Davy. Dated August 2nd.

14,739. "Improvements in holders for incandescent electric lamps." J. M. Huisman and H. C. Gover. Dated August 2nd.

14,792. "Improvements in electric arc lamps." The Rogers Arc Lamp Company, Limited, and J. W. Rogers. Dated August 2nd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

7,205. "A new or improved process for the electro-deposition of aluminium and aluminium alloys." A. F. B. Gomess. Dated April 11th. After having prepared the article to be plated in the ordinary way, or by any suitable means as practised for the deposition of silver and other metals, the inventor electro-deposits the aluminium, or aluminium alloy, by the employment of a bath consisting of a solution of tartrate of aluminium in conjunction with chloride of an alkali either with or without the addition of iodide or bromide of an alkali. This bath may be used either hot or cold. 8 claims.

10,701. "Improvements in electrical connections for marine purposes." C. S. Snell. Dated June 1st. The inventor makes use of a vertical spar, to which is attached the cable from the shore or other desirable point, and at the upper end of the spar he arranges an electrical connection, free to swivel, part of which is connected with the continuation of the cable to the ship or vessel. 2 claims.

11,286. "Improvements in electric arc lamps." H. C. L. Holden. Dated June 11th. Both the positive and also the negative carbons are contained in holders which may conveniently be in the form of metal tubes, and through these metal tubes or holders the carbons are pressed by the force of springs, weights, or gravity, at the same rate and at the same time as each carbon is consumed in the arc. The carbons themselves are prevented from being forced completely out of their holders by one or more screws, or an equivalent device or devices, which, abutting against the consumable part of the carbon, in proximity to the arc itself, regulate the forward feed of the carbon rod in its holder automatically to suit the requirements of the current and voltage. 1 claim.

12,407. "Improvements in cable transmitters." H. A. Taylor. Dated June 26th. Consists in dispensing with the rocking lever, and substituting for it a pair of cams. 3 claims.

12,552. "Improvements in protecting, and in fittings for connecting, lead-covered or other armoured electric cables with naked or other conductors." G. H. Nisbett. Dated June 28th. Has for its object an arrangement whereby an armoured cable, more especially a lead-covered one, can be connected with terminals or with other cables in such a manner that the dielectric surrounding the conductor shall be protected from moisture or other atmospheric influences. 3 claims.

12,707. "Improvements in or connected with electric lamp-holders, sockets, or connections. J. B. Verity. Dated June 30th. Consists of a moulding block of china or other insulating material provided with the necessary connection screws and contact plungers mounted in such a manner that the china or other block itself forms the guides or cylinders in which the contact plungers and their springs are placed without the use of metal cylinders, which have hitherto always been used. 4 claims.

12,973. "An improved device for casting electric accumulator plates." C. Hampel. Dated July 4th. Relates to a device for casting electric accumulator plates having the form of lattice work, the interstices of which become narrower from the inside to the outside. 2 claims.

13,148. "Improvements in electrical measuring and recording instruments." H. T. Harrison. Dated July 6th. Relates to that class of electrical instruments which records the variation of current or pressure in an electrical circuit by means of a pen moving over a properly divided chart or paper which is moved longitudinally beneath it at a constant speed, by means of clockwork or other suitable mechanism. 5 claims.

13,581. "Improvements in electric cables." S. P. Thompson. (Under International Convention.) Dated December 19th, 1893. In the case of a single wire cable the inventor joins on to the conductor at intervals compensating branches, which, for telegraphic purposes, may be as much as 200, or even 500 miles apart, and for telephonic purposes as near together as 20 or 40 miles, according to the nature and total length of the cable. Each compensating branch consists of a short conductor in metallic connection with the conductor within the cable, and thoroughly insulated with the usual coatings and sheathings, so as to prevent the admission of water to the main cable and to the insulated part of the branch, the branch being provided at its extremity with an exposed metallic terminal, which, being in contact with the water, forms an "earth-plate," or in lieu thereof, being connected to the iron sheathing of the cable, so that the same may act as earth or earth plate. The branch possesses resistance and self-induction, and is so proportioned that it forms a leak on the cable of a definite and determined kind, that is to say, it constitutes a leak differing from an accidental leak, in that it possesses a definite resistance and a definite self-induction, both of which qualities remain practically constant, and are not liable to change by corrosion, as accidental leaks will do. 6 claims.

14,080. "Improvements in incandescent electric lamps." G. F. Redfern. (A communication by C. Schwabe, of Berlin.) Dated July 21st. The upper part of the lamp is furnished with a metallic casing, which serves as a reflector, whilst the lower part of the bulb is made dull by any suitable means. 1 claim.

14,691. "Improvements in governing devices for motors." H. H. Lake. (Communicated from abroad by Cie de l'Industrie Electrique, Geneva.) Dated July 31st. The regulating device is combined so as not to exceed the normal point of regulation, as this occurs in most of the similar devices known till now. 1 claim.

14,987. "Improvements in or relating to the separation of caustic alkalies from the liquors obtained by the electrolysis of alkaline salts." W. L. Wise. (A communication from Solvay & Co., of Brussels.) Dated August 4th. Relates more particularly to a washing process. The mixture of salt and caustic liquor is placed in a vessel that may be of cylindrical form, provided with a double casing for enabling it to be heated by means of steam, and with a false bottom for keeping back the solid portion and allowing only the liquid portion to pass through. The whole is heated to a temperature of approximately 100° C., after which there is poured on the top of the mixture, by means of a suitable apparatus that will not cause the mixing of the contents of the vessel, a layer of saturated salt water or brine equal in volume to the volume of the caustic solution with which the precipitated salt is impregnated. On opening a discharge cock at the bottom of the said vessel, a displacement of a molecular nature, so to speak, is produced. The caustic solution is expelled practically in successive horizontal layers, and is replaced by the salt water without any mixing taking place. 2 claims.

17,379. "A safety device for electrical elevators or cranes." B. Willcox. (Communicated from abroad by Eisenwerk vormals Nagel and Kaemp Actien Gesellschaft, of Uhlenhorst, Hamburg.) Dated September 12th. Consists of a roller or pulley, or the like, mounted upon one arm of a lever, over which roller, pulley, or the like, the load-supporting chain or rope is passed, while the other arm of the lever is weighted by means of a counter-weight or its equivalent, a spring, in such a manner that normal loads are not capable of drawing down the arm of the lever carrying the roller pulley, or the like, and raising the weight. When, however, the allowed maximum load is exceeded, the pressure of the weight or spring is overcome, whereby the lever is caused to turn on its centre, and in its movement it actuates an instantaneous switch, so that the current is interrupted and the elevator or crane ceases to be operated. 1 claim.

17,741. "Improvements in, or relating to, galvanic batteries." W. P. Thompson. (A communication by A. Lessing, of Nuremberg.) Dated September 18th. Provides a method by which the zinc cylinder and conductor may be made in one piece in the simplest manner